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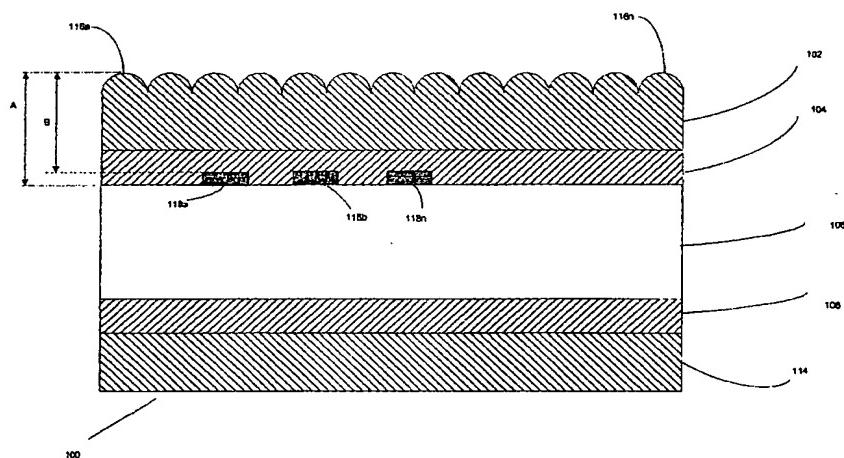
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(54) Title: MULTIPLE IMAGE SECURITY FEATURES FOR IDENTIFICATION DOCUMENTS AND METHODS OF MAKING SAME



**WO 03/052680 A1**

(57) Abstract: A method for making a secure ID card (100) with multiple images is provided. Information is provided to an information bearing layer (106) which is disposed beneath an outer laminate layer (102), another laminate layer is 114 having lenticules (116a) through (116n) formed thereon, the information (118a) through (118n) constructed and arranged to be capable of providing multiple images when printed information is viewed at different predetermined angles through an appropriate lens. The first surface (104) can also include other information (another surface is 108).



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**MULTIPLE IMAGE SECURITY FEATURES FOR IDENTIFICATION DOCUMENTS AND**  
**METHODS OF MAKING SAME**

5    **Related Application Data**

The present application is related to U.S. Patent Application Nos. 09/747,735, filed December 22, 2000, 09/602,313, filed June 23, 2000, and 10/094,593, filed March 6, 2002, U.S. Provisional Patent Application No. 60/358,321, filed February 19, 2002, as well as U.S. Patent No. 6,066,594. Each of the above U.S. Patent documents is herein incorporated by reference.

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**Priority**

This application claims the priority of the following United States Provisional Applications, the contents of which are incorporated herein by reference in their entirety:

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- Multiple Image Feature For Identification Document (Attorney Docket No. P0526 -- Inventor: Brian Labrec), Serial No. 60/344718, filed December 24, 2001;
- Secure ID Card with Multiple Images and Methods of Making (Attorney Docket No. P0529 -- Inventor Brian Labrec), Serial No. 60/344683, filed December 24, 2001; and
- Secure ID Card with Multiple Images and Method of Making (Attorney Docket NO. P0566 -- Inventor Brian Labrec), Serial No. 60/341569

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**Field**

The invention relates in general to an information-bearing laminar assembly suitable for use as an identification card, and more particularly, to an information-bearing laminar assembly having thereon a plurality of lenticular lens elements that provide a multiple image security feature.

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**Background**

Identification documents (hereafter "ID documents") play a critical role in today's society. One example of an ID document is an identification card ("ID card"). ID documents are used on a daily basis -- to prove identity, to verify age, to access a secure area, to evidence driving privileges, to cash a check, and so on. Airplane passengers are required to show an ID document during check in, security screening, and prior to boarding their flight. In addition, because we live in an ever-evolving cashless society, ID documents are used to make payments, access an ATM, debit an account, or make a payment, etc.

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Many types of identification cards and documents, such as driving licenses, national or government identification cards, bank cards, credit cards, controlled access cards and smart cards, carry thereon certain items of information which relate to the identity of the bearer. Examples of such information include name, address, birth date, signature and photographic image; the cards or documents may in addition carry other variant data (i.e., data specific to a particular card or document, for example an employee number)

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and invariant data (i.e., data common to a large number of cards, for example the name of an employer). All of the cards described above will hereinafter be generically referred to as "ID documents".

In the production of images useful in the field of identification documentation, it is oftentimes desirable to embody into a document (such as an ID card, drivers license, passport or the like) data or indicia representative of the document issuer (e.g., an official seal, or the name or mark of a company or educational institution) and data or indicia representative of the document bearer (e.g., a photographic likeness, name or address). Typically, a pattern, logo or other distinctive marking representative of the document issuer will serve as a means of verifying the authenticity, genuineness or valid issuance of the document. A photographic likeness or other data or indicia personal to the bearer will validate the right of access to certain facilities or the prior authorization to engage in commercial transactions and activities.

Identification documents, such as ID cards, having printed background security patterns, designs or logos and identification data personal to the card bearer have been known and are described, for example, in U.S. Pat. No. 3,758,970, issued Sep. 18, 1973 to M. Annenberg; in Great Britain Pat. No. 1,472,581, issued to G. A. O. Gesellschaft Fur Automation Und Organisation mbH, published Mar. 10, 1976; in International Patent Application PCT/GB82/00150, published Nov. 25, 1982 as Publication No. WO 82/04149; in U.S. Pat. No. 4,653,775, issued Mar. 31, 1987 to T. Raphael, et al.; in U.S. Pat. No. 4,738,949, issued Apr. 19, 1988 to G. S. Sethi, et al.; and in U.S. Pat. No. 5,261,987, issued Nov. 16 1993 to J. W. Luening, et al. All of the aforementioned documents are hereby incorporated by reference.

The advent of commercial apparatus (printers) for producing dye images by thermal transfer has made relatively commonplace the production of color prints from electronic data acquired by a video camera. In general, this is accomplished by the acquisition of digital image information (electronic signals) representative of the red, green and blue content of an original, using color filters or other known means. These signals are then utilized to print an image onto a data carrier. For example, information can be printed using a printer having a plurality of small heating elements (e.g., pins) for imagewise heating of each of a series of donor sheets (respectively, carrying sublimable cyan, magenta and yellow dye). The donor sheets are brought into contact with an image-receiving element (which can, for example, be a substrate) which has a layer for receiving the dyes transferred imagewise from the donor sheets. Thermal dye transfer methods as aforesaid are known and described, for example, in U.S. Pat. No. 4,621,271, issued Nov. 4, 1986 to S. Brownstein and U.S. Pat. No. 5,024,989, issued Jun. 18, 1991 to Y. H. Chiang, et al.

Each of these patents is hereby incorporated by reference.

Commercial systems for issuing ID documents are of two main types, namely so-called "central" issue (CI), and so-called "on-the-spot" or "over-the-counter" (OTC) issue.

CI type ID documents are not immediately provided to the bearer, but are later issued to the bearer from a central location. For example, in one type of CI environment, a bearer reports to a document station where data is collected, the data are forwarded to a central location where the card is produced, and the card is forwarded to the bearer, often by mail. Another illustrative example of a CI assembling process occurs in a setting where a driver passes a driving test, but then receives her license in the mail from a CI

facility a short time later. Still another illustrative example of a CI assembling process occurs in a setting where a driver renews her license by mail or over the Internet, then receives a drivers license card through the mail.

Centrally issued identification documents can be produced from digitally stored information and  
5 generally comprise an opaque core material (also referred to as "substrate"), such as paper or plastic, sandwiched between two layers of clear plastic laminate, such as polyester, to protect the aforementioned items of information from wear, exposure to the elements and tampering. The materials used in such CI identification documents can offer the ultimate in durability. In addition, centrally issued digital identification documents generally offer a higher level of security than OTC identification documents  
10 because they offer the ability to pre-print the core of the central issue document with security features such as "micro-printing", ultra-violet security features, security indicia and other features currently unique to centrally issued identification documents. Another security advantage with centrally issued documents is that the security features and/or secured materials used to make those features are centrally located, reducing the chances of loss or theft (as compared to having secured materials dispersed over a wide  
15 number of "on the spot" locations).

In addition, a CI assembling process can be more of a bulk process facility, in which many cards are produced in a centralized facility, one after another. The CI facility may, for example, process thousands of cards in a continuous manner. Because the processing occurs in bulk, CI can have an increase in efficiency as compared to some OTC processes, especially those OTC processes that run intermittently.  
20 Thus, CI processes can sometimes have a lower cost per ID document, if a large volume of ID documents are manufactured.

In contrast to CI identification documents, OTC identification documents are issued immediately to a bearer who is present at a document-issuing station. An OTC assembling process provides an ID document "on-the-spot". (An illustrative example of an OTC assembling process is a Department of Motor  
25 Vehicles ("DMV") setting where a driver's license is issued to person, on the spot, after a successful exam.). In some instances, the very nature of the OTC assembling process results in small, sometimes compact, printing and card assemblers for printing the ID document.

OTC identification documents of the types mentioned above can take a number of forms, depending on cost and desired features. Some OTC ID documents comprise highly plasticized polyvinyl chloride (PVC) or have a composite structure with polyester laminated to 0.5-2.0 mil (13-51 .mu.m) PVC film, which provides a suitable receiving layer for heat transferable dyes which form a photographic image, together with any variant or invariant data required for the identification of the bearer. These data are subsequently protected to varying degrees by clear, thin (0.125-0.250 mil, 3-6 .mu.m) overlay patches applied at the print head, holographic hot stamp foils (0.125-0.250 mil 3-6 .mu.m), or a clear polyester  
30 laminate (0.5-10 mil, 13-254 .mu.m) supporting common security features. These last two types of protective foil or laminate sometimes are applied at a laminating station separate from the print head. The  
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choice of laminate dictates the degree of durability and security imparted to the system in protecting the image and other data.

Figs. 1 and 2 illustrate a front view and cross-sectional view (taken along the A-A line), respectively, of an exemplary prior art identification (ID) document 10. In FIG. 1, the prior art ID 5 document 1 includes a photographic image 12, a bar code 14 (which may contain information specific to the person whose image appears in photographic image 12 and/or information that is the same from ID document to ID document), variable personal information 16, such as an address, signature, and/or birthdate, and biometric information 18 associated with the person whose image appears in photographic image 12 (e.g., a fingerprint). Although not illustrated in FIG. 1, the ID document 10 can include a 10 magnetic stripe (which, for example, can be on the rear side (not shown) of the ID document 10), and various security features, such as a security pattern (for example, a printed pattern comprising a tightly printed pattern of finely divided printed and unprinted areas in close proximity to each other, such as a fine-line printed security pattern as is used in the printing of banknote paper, stock certificates, and the like).

15 Referring to FIG. 2, the ID document 10 comprises a pre-printed core 20 (such as, for example, white polyvinyl chloride (PVC) material) that is, for example, about 25 mil thick. The core 20 is laminated with a transparent material, such as clear PVC material 22, which, by way of example, can be about 1-5 mil thick. The composite of the core 20 and clear PVC material 22 form a so-called "card blank" 25 that can be up to about 30 mils thick. Information 26a-c is printed on the card blank 25 using a method such as Dye 20 Diffusion Thermal Transfer ("D2T2") printing (described further in commonly assigned United States Patent No. 6066594, which is incorporated hereto by reference in its entirety.) The information 26a-c can, for example, comprise an indicium or indicia, such as the invariant or nonvarying information common to a large number of identification documents, for example the name and logo of the organization issuing the documents. The information 26a-c may be formed by any known process capable of forming the indicium 25 on the specific core material used.

To protect the information 26a-c that is printed, an additional layer of overlaminates 24 can be coupled to the card blank 25 and printing 26a-c using, for example, 1 mil of adhesive (not shown). The overlaminates 24 can be substantially transparent. Materials suitable for forming such protective layers are known to those skilled in the art of making identification documents and any of the conventional materials 30 may be used provided they have sufficient transparency. Examples of usable materials for overlaminates include biaxially oriented polyester or other optically clear durable plastic film.

Because ID documents 10 can be used to enable and facilitate personal identification, it often is desirable to manufacture the ID document 10 in a manner to deter counterfeiting and/or fraudulent alteration. There are a number of known ways to increase the security of ID documents 10, including 35 methods that incorporate additional information or security features and methods that adapt existing information on the card to help prevent or make evident fraud. For example, numerous types of laminations have been employed in which the information-bearing surface is heat or solvent-laminated to a

transparent surface. The materials for and the process of lamination are selected such that if an attempt is made to uncover the information-bearing surface for amendment thereof, the surface is destroyed, defaced or otherwise rendered apparent the attempted intrusion.

While an identification card that essentially cannot be disassembled without being destroyed may 5 provide suitable resistance against fraudulent alteration, it might not significantly challenge all attempts of counterfeiting. The counterfeiting of identification cards also can involve the fabrication and issuance of identification cards by persons not authorized to do so. Such counterfeiting presents additional and different security problems to the art. One possible way of preventing fraudulent fabrication and issuing could involve strict control over the possession of the materials and equipment involved in the fabrication 10 of the identification card. In some instances, however, this approach is impractical and/or impossible, especially if any of the materials involved are commercially available and used in other applications.

One response to the counterfeiting problem has involved the integration of verification features that are difficult to copy by hand or by machine. One such verification feature is the use in the card of a signature of the card's issuer or bearer. Other verification features have involved, for example, the use of 15 watermarks, biometric information, microprinting, fluorescent materials, fine line details, validation patterns or marking, and polarizing stripes. These verification features are integrated into an identification card in various ways and they may be visible or invisible in the finished card. If invisible, they can be detected by viewing the feature under conditions which render it visible. At least some of the verification features discussed above have been employed to help prevent and/or discourage counterfeiting. However, 20 at least some of the features can be expensive and, in the case of features hidden from casual visual inspection, require specialized equipment and trained operator for authentication. It would be advantageous if an ID document included a security feature that would be difficult to reproduce either in a counterfeited document or by the fraudulent alteration of an original, but would for authentication require neither specialized equipment nor trained operators.

25 One possible solution to the desire to provide visible, self-authenticating security features on cards is using a so-called lenticular lens and lenticular image. A lenticular image is comprised of a sequence of images that are interlaced to form a singular image, where each individual image (or frame) is viewable at a different angle to the viewer when viewed through a lenticular lens. These various images are termed views.

30 For example, U.S. Patent No. 4,869,946 ("the '946 patent") issued September 26, 1989 describes a tamperproof security card comprised of a transparent upper layer having narrow parallel lenses on the outer surface, and an image containing substrate, the two layers forming a lenticular system by which images on the substrate are selectively visible depending upon the angle from which the card is viewed. The disclosure of this patent, insofar as it relates to the structure and operation of lenticular systems, is 35 incorporated herein by reference. The embodiments disclosed in the '946 patent appear to contemplate having lenticular lens material over the entire surface of a card. In addition, the '946 patent states that the

individual data image which is to be viewed through the lenticular lens is formed by laying down a photographic emulsion on an image substrate layer by means of a lenticular system (col. 3, lines 11-20).

Summary

5 It can be very difficult to print variable/personalized information on ID documents using known methods, especially if the variable/personalized information varies in type, size, and location from card to card and if it is not desired that the entire card incorporate a lenticular lens feature. Because registration of the image to the lens can be important in ensuring good transitions in image appearance from one view to another, known systems have used simpler lenticular lens features, such as using the same pair of images  
10 (e.g., a pair of logos) on every card. A number of known systems, such as the '946 patent, also utilize the lens itself as a means to lay down the image to be viewed by it. One prior art system even uses a laser to engrave an image through the lenticular lens. Using the lens to create an image can be impractical for high volume applications (such as the aforementioned CI systems), where variable image data is printed on a core or substrate and/or on a laminate affixed to the core or substrate. In some situations, using a lens to  
15 create an image might limit the quality of the resultant image, because the angle at which the information is written requires a high degree of precision, increasing manufacturing costs.

Some other known systems print the multiple images on the lens itself, instead of on the substrate to which the lens attaches. Printing on the lens can make it difficult to achieve good registration between the lens and the image, which can result in poor image transition from one image to the other as image is  
20 viewed at varying angles. Printing on the lens also can limit the ability to handle images of varying sizes. Further, printing on a lens can be very difficult to do in high volume manufacturing environments such as making drivers licenses, because drivers licenses can have several formats which vary for different holders (e.g. under 21 driver, learners, and driver ID), and the aforementioned CI type driver license system can produce licenses for more than one state, which might involve using different art work and security features  
25 in different locations. It is inconvenient and expensive to have to change consumables (e.g., lens sheets) to enable varied printing.

It could be advantageous if the variable or personalized information associated with a card bearer could be used as a security feature, in a manner where the security feature is difficult to detect and/or duplicates, yet still able to be printable on the card at the time of card personalization. It could be  
30 advantageous if an identification document with a multiple image lenticular lens feature that uses personal information could be manufactured using conventional, inexpensive consumables already being used in the manufacture of identification documents (e.g., without requiring the use of expensive lenticular lens sheets). It further could be advantageous if an identification document could have a personalized full color multiple image lenticular lens feature.

35 In accordance with one embodiment of the invention, systems and methods are provided for making a secure ID card with multiple images. Printed information in the form of an interlaced image (which includes the interlacing of at least two images) is provided to an information-bearing layer. A

substantially transparent film material is provided to substantially cover the information-bearing layer. A lens profile is embossed in a selected portion of the film material, such as the portion that at least partially covers the interlaced material. The portion of the interlaced image that is covered by the lenticular lens will present a different appearance depending on the angle at which the interlaced image is viewed. With the  
5 arrangement of the first embodiment, a secure ID card with multiple images security feature can be provided on a portion of the ID card while information on the other portions of the ID card are not obscured by the lenticular lens. In accordance with a further aspect of the invention, the lenticular lens can be fabricated prior to ID card construction and aligned with the ID card in order to provide the multiple images security feature on a portion of the ID card.

10 In one embodiment, a method for making a secure ID card with multiple images is provided. Information is provided to an information bearing layer, the information constructed and arranged to be capable of providing multiple images when printed information is viewed at different predetermined angles through an appropriate lens. At least a portion of the information is covered with a substantially a transparent film material. A lens profile is embossed on at least a second portion of the film material, the  
15 embossing forming a lens on the film material, the lens enabling the information to display multiple images when the information-bearing laminar assembly is viewed at different predetermined angles.

In one embodiment, the invention provides an information bearing document having at least first side, the information bearing document comprising a core layer, an interlaced image, and a lenticular lens. The interlaced image is formed on the core layer, the interlaced image comprising at least two images  
20 constructed and arranged to provide at least two images when the interlaced image is viewed through a predetermined lenticular lens through at least two different predetermined angles. The lenticular lens is operably coupled to at least a portion of the interlaced image, the lenticular lens constructed and arranged to be operable with the interlaced image to enable at least two images in the interlaced image to be viewable through the lenticular lens at two different angles.

25 The foregoing and other features and advantages of the present invention will be even more readily apparent from the following Detailed Description, which proceeds with reference to the accompanying drawings.

30 Brief Description of the Drawings

The advantages, features, and aspects of embodiments of the invention will be more fully understood in conjunction with the following detailed description and accompanying drawings, wherein:

FIG. 1 is an illustrative example of a prior art identification document;

35 FIG. 2 is an illustrative cross section of the prior art identification document of FIG. 1, taken along the A-A line; FIG. 3 is a view of an ID document illustrating the multiple images, in accordance with one embodiment of the invention;

FIG. 4 is a cross-sectional schematic view of the ID document of FIG. 3, taken generally across line 1C-1C of FIG. 3;

FIG. 5 is a top schematic view of the ID document of FIG. 3, viewed from a first angle;

FIG. 6 is a top schematic view the ID document of FIG. 3, viewed from a second angle;

5 FIGs. 7A-B are illustrative examples of a first security image, in original and pre-interlaced form, respectively, relevant to the creation of a multiple image security feature shown in the ID document of FIG. 3;

10 FIGs. 8A-8B are illustrative examples of a second security image, in original and pre-interlaced form, respectively, relevant to the creation of a multiple image security feature shown in the ID document of FIG. 3;

FIG. 9 is an illustrative example of a multiple image security feature created by interlacing the first and second security images of FIGs. 7A, 7B, 8A, and 8B, in accordance with one embodiment of the invention;

15 FIG. 10 is an illustrative flow chart showing a method for creating the multiple image security feature of FIG. 9, in accordance with one embodiment of the invention;

FIG. 11 is an illustrative diagram of a first central issue card production system that can be used to produce the ID document of FIG. 3, in accordance with one embodiment of the invention;

FIG. 12 is a detailed view of a portion of the embosser of FIG. 11;

20 FIGs 13A-D are front, cross-sectional, enlarged, and perspective views, respectively of the lenticular die of the embosser of FIG. 11;

FIGs. 14A-D are cross-sectional, perspective, side, and edge views, respectively, of the insulator plate of the embosser of FIG. 11;

FIGs. 15A-D are top, cross-sectional, edge, and perspective views, respectively, of the heater bar of the insulator plate of FIGs. 14A-D and FIG. 11;

25 FIG. 16 is a flow chart of a first method for manufacturing the ID document of FIG. 3 using the system of FIG. 11, in accordance with one embodiment of the invention;

FIG. 17 is a flow chart of a second method for manufacturing the ID document of FIG. 3 in a central issue environment;

30 FIG. 18 is an illustrative diagram of a second central issue card production system that can be used to produce the ID document of FIG. 3, in accordance with one embodiment of the invention; and

FIG. 19 is an illustration of a portion of a laminate roll showing a laminate with lenticular lenses embossed thereon.

The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In addition, in the figures, like numbers refer to like elements.

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#### Detailed Description of the Invention

In the foregoing discussion, the use of the word "ID document" is broadly defined and intended to include all types of ID documents, including (but not limited to), documents, magnetic disks, credit cards, bank cards, phone cards, stored value cards, prepaid cards, smart cards (e.g., cards that include one or more semiconductor chips, such as memory devices, microprocessors, and microcontrollers), contact cards, 5 contactless cards, proximity cards (e.g., radio frequency (RFID) cards), passports, driver's licenses, network access cards, employee badges, debit cards, security cards, visas, immigration documentation, national ID cards, citizenship cards, social security cards and badges, certificates, identification cards or documents, voter registration and/or identification cards, police ID cards, border crossing cards, security clearance badges and cards, gun permits, badges, gift certificates or cards, membership cards or badges, 10 and tags. It is even contemplated that aspects of the invention may have applicability for devices such as compact disks, consumer products, knobs, keyboards, electronic components, etc., or any other suitable items or articles that may record information, images, and/or other data, which may be associated with a function and/or an object or other entity to be identified. Note also that, for the purposes of this disclosure, the terms "document," "card," "badge" and "documentation" are used interchangeably.

15 In addition, in the foregoing discussion, "identification" includes (but is not limited to) information, decoration, and any other purpose for which an indicia can be placed upon an article in the article's raw, partially prepared, or final state. Also, instead of ID documents, the inventive techniques can be employed with product tags, product packaging, business cards, bags, charts, maps, labels, etc., etc., particularly those items including marking of an laminate or over-laminate structure. The term ID 20 document thus is broadly defined herein to include these tags, labels, packaging, cards, etc.

"Personalization", "Personalized data" and "variable" data are used interchangeably herein, and refer at least to data, images, and information that is "personal to" or "specific to" a specific cardholder or group of cardholders. Personalized data can include data that is unique to a specific cardholder (such as biometric information, image information, serial numbers, Social Security Numbers, privileges a 25 cardholder may have, etc.), but is not limited to unique data. Personalized data can include some data, such as birthdate, height, weight, eye color, address, etc., that are personal to a specific cardholder but not necessarily unique to that cardholder (for example, other cardholders might share the same personal data, such as birthdate). In at least some embodiments of the invention, personal/variable data can include some fixed data, as well.

30 "Laminate" and "overlaminate" include (but are not limited to) film and sheet products. Laminates usable with at least some embodiments of the invention include those which contain substantially transparent polymers and/or substantially transparent adhesives, or which have substantially transparent polymers and/or substantially transparent adhesives as a part of their structure, e.g., as an extruded feature. Examples of potentially usable laminates include at least polyester, polycarbonate, polystyrene, cellulose 35 ester, polyolefin, polysulfone, and polyamide. Laminates can be made using either an amorphous or biaxially oriented polymer as well. The laminate can comprise a plurality of separate laminate layers, for example a boundary layer and/or a film layer. Other possibly usable laminates include security laminates,

such as a transparent laminate material with proprietary security technology features and processes, which protects documents of value from counterfeiting, data alteration, photo substitution, duplication (including color photocopying), and simulation by use of materials and technologies that are commonly available.

Laminates also can include thermosetting materials, such as epoxy. Laminates can include synthetic resin-  
5 impregnated or coated base materials composed of successive layers of material, bonded together via heat, pressure, and/or adhesive.

The material(s) from which a laminate is made may be transparent, but need not be. The degree of transparency of the laminate can, for example, be dictated by the information contained within the identification document, the particular colors and/or security features used, etc. The thickness of the

10 laminate layers is not critical, although in some embodiments it may be preferred that the thickness of a laminate layer be about 1-20 mils. Lamination of any laminate layer(s) to any other layer of material (e.g., a core layer) can be accomplished using any conventional lamination process, and such processes are well known to those skilled in the production of articles such as identification documents. Of course, the types and structures of the laminates described herein are provided only by way of example, those skilled in the  
15 art will appreciate that many different types of laminates are usable in accordance with the invention.

Various lamination processes are disclosed in assignee's U.S. Patent Nos. 5,783,024, 6,007,660, 6066594, and 6,159,327. Other lamination processes are disclosed, e.g., in U.S. patent Nos. 6,283,188 and 6,003,581. Each of these U.S. Patents is herein incorporated by reference.

For purposes of illustration, the following description will proceed with reference to ID document structures (such as TESLIN-core, multi-layered ID documents) and fused polycarbonate structures. It should be appreciated, however, that the present invention is not so limited. Indeed, as those skilled in the art will appreciate, the inventive techniques can be applied to many other structures formed in many different ways to provide a multiple image feature thereon. Generally, the invention has applicability for virtually any product which is to be printed and especially those products which need to be uniquely  
25 identified and/or protected against fraud and/or tampering. For example, at least some embodiments of the invention are usable to form multiple image features on articles formed from paper, wood, cardboard, paperboard, glass, metal, plastic, fabric, ceramic, rubber, along with many man-made materials, such as microporous materials, single phase materials, two phase materials, coated paper, synthetic paper (e.g., TYVEC, manufactured by Dupont Corp of Wilmington, Delaware), foamed polypropylene film (including  
30 calcium carbonate foamed polypropylene film), plastic, polyolefin, polyester, polyethylenetelphthalate (PET), PET-G, PET-F, and polyvinyl chloride (PVC), and combinations thereof.

It is further anticipated that the invention could even have applicability in manufacturing articles which are to have a multiple image feature formed thereon, but where the multiple image feature is not necessarily provided as a security feature. For example, it is anticipated that the invention has applicability  
35 in forming decorative multiple image features and/or customized multiple image features.

In one embodiment, the invention provides a novel information-bearing laminar assembly that would be suitable for use as or incorporated into an identification document, such as the ID document 10 of

FIG. 1. The information-bearing laminar assembly of this embodiment is characterized by the provision therein, as a security feature, a lenticular lens portion disposed on an outer transparent layer, which provides multiple images in conjunction with information printed on an information-bearing layer. In at least one embodiment, the multiple images include at least one image that includes variable/personal information. In at least one embodiment, the multiple images include at least one color image, such as a full color portrait.

5 FIG. 3 is a view of an information bearing laminar assembly 100 (also referred to as ID card 100) illustrating the multiple images, in accordance with one embodiment of the invention, and FIG. 4 is a cross-sectional schematic view of the ID card 100 of FIG. 3, taken generally across line 1C-1C of FIG. 3. Note  
10 that the view of FIG. 3, in which both of the variable images are visible, is not a view that necessarily can be seen by a user, but is merely provided to illustrate the juxtaposition and location of the multiple images. As the ID card 100 is rotated, the security images 130, 130' appear to "disappear" as shown in FIGS. 5 and  
15 6. The disappearance of the image is due to the focus of the lens in the areas of no print. As the ID card 100 is rotated about its horizontal axis, the focal point of the lens moves vertically up or down and oscillates between the two images. The lens feature magnifies the print located at this focal point, resulting in expanding the print to appear as a continuous single image. In at least one embodiment, instead of lines, individual dots (e.g., of ink or toner) could be used to represent the line and the feature would work in the same manner.

Referring to FIGs. 3 and 4, the ID card 100 includes an information-bearing layer 106 having a  
20 first surface 104. The first surface 104 includes a multiple image portion 120 which further includes first and second security images 130, 130'. For illustrative purposes only, the first security image 130 is shown as a reduced size portrait 130 (which, for security purposes, can match the standard size portrait 122), and the second security image 130', is shown to be a birthdate. The first and second security images 130, 130' can, however, be virtually any type of information that is useful and/or usable, given the type and use of the  
25 ID card 100. For example, the first and second security images 130, 130' can be any pair chosen from information such as biometric information (e.g., fingerprint), signatures, birthdates, serial numbers, government identification numbers (e.g., Social Security Numbers), images of the bearer of the ID card 100, address, account number, security classification, expiration date, and the like. Although it is advantageous for security purposes that one or both of the first and second security images 130, 130'  
30 include variable/personal information, in at least one embodiment it is not necessary that either (or both) security images comprise variable information. In one embodiment, for example, the first and second security images 130, 130' could comprise nonvarying information, especially if the nonvarying information is printed using a substance (e.g., optically varying or non-visible ink) that increases the difficulty of copying the ID card 100. In one embodiment either or both of the security images could comprise pre-printed fixed or nonvarying information. Furthermore, those skilled in the art will appreciate that many  
35 different types of information (in fact, virtually any type of information) is usable. For example, in one

embodiment of the invention, either or both of the security images are color images, such as single color images, pearlescent colors, rainbow colors, multicolors, and full colors.

Note that the invention is not limited to using any specific inks or equipment to print any of the features, including the interlaced images described herein. Inks such as ultraviolet (UV), infrared (IR), etc. are usable in at least some embodiments of the invention, as well as inks that are toner-based and/or UV-curable. Further, in at least some embodiments of the invention, the equipment and/or printing presses used can include offset, digital variable offset, inkjet, laser toner-based, etc.

It also will be appreciated that the first and second security images 130, 130', in at least some embodiments, can even comprise the same image or different forms of the same image. For example, the first security image 130 could be a front facing portrait of a card bearer and the second security image 130' could be a profile image of the card bearer. In at least some embodiments, the first security image 130 could be a visible portrait image of a card bearer and the second security image 130' could be the same portrait image of the card bearer, but printed in a non-visible ink (e.g., UV or IR ink) or an optically variable ink. Many different possible combinations are contemplated to be within the spirit and scope of the invention.

Referring again to FIGs. 3 and 4, the first surface 104 also can include other information, such as fixed information 19 (here, the name of the issuing authority) and variable/personal information, such as, a portrait 122, an address 16 and biometric information 18. Note that any or all of the variable/personal information could be part of the multiple image portion 120.

FIG. 5 is a top schematic view of the ID document of FIG. 3, viewed from a first angle, showing that only the first security image 130 is visible at the first angle. FIG. 6 is a top schematic view of the ID document of FIG. 3, viewed from a second angle, showing that only the second security image 130' is visible at the second angle.

Referring again to FIG. 4, it can be seen that the information-bearing inner layer 106 is disposed beneath a light transmissive outer laminate layer 102 having lenticules 116a through 116n formed thereon. The lenticules 116 and laminate layer 102 together form a lenticular lens. At time, in this specification, "lenticule" and "lenticular lens" may be used interchangeably. The illustrative embodiment of FIG. 4 illustrates that the information bearing inner layer 106 is interposed between two light transmissive outer layers 102 and 114, but not all embodiments of the invention require that there be light transmissive outer layers affixed to both surfaces of the information bearing inner layer 106.

In at least one embodiment, the information bearing inner layer 106 corresponds to a core layer (also referred to as a substrate) of an identification document. In at least one embodiment, the information bearing inner layer 106 is made from a substantially opaque material, such as TESLIN. Other rigid or semi-rigid planar materials can, of course, be used. Further, it will be appreciated that the invention can be adapted to work with many other materials used as an information bearing layer 106, such as thermoplastic, polymer, copolymer, polycarbonate, fused polycarbonate, polyester, amorphous polyester, polyolefin, silicon-filled polyolefin, foamed polypropylene film, polyvinyl chloride, polyethylene, thermoplastic resins,

engineering thermoplastic, polyurethane, polyamide, polystyrene, expanded polypropylene, polypropylene, acrylonitrile butadiene styrene (ABS), ABS/PC, high impact polystyrene, polyethylene terephthalate (PET), PET-G, PET-F, polybutylene terephthalate PBT), acetal copolymer (POM), polyetherimide (PEI), polyacrylate, poly(4-vinylpyridine, poly(vinyl acetate), polyacrylonitrile, polymeric liquid crystal resin, polysulfone, polyether nitride, and polycaprolactone, and combinations thereof.

5 In the illustrated embodiment of FIG. 4, the two illustrated light-transmissive outer layers are adhered to the inner information-bearing layer 106 by two adhesive layers 110 and 112, respectively. The adhesives layers 110, 112 need not be provided separately, but could be already formed on the laminate layer 102. The first outer light-transmissive layer 102 is adhered to the inner information-bearing layer 106  
10 by the first adhesive layer 110 and the second outer light transmissive layer 114 is adhered to the inner information-bearing layer 106 by the second adhesive layer 112. The outer layer 102 includes a series of parallel lenticular lenses 116a - 116n (generally referred to as lenticular lens 116) which are formed as described below in conjunction with FIGs. 11-17.

15 In at least one embodiment, some of the 118a-118n includes variable/personal information and is provided on the surface 104 of inner information-bearing layer 106 that is used in cooperation with the lenticular lenses 116, to provide the multiple image optical effect. In at least one embodiment of the invention, the information 118 includes interlaced images that include a color portrait (the creation of such images is discussed further herein). The information 118 also could include text or graphics that is representative of data desired to be displayed in the information bearing document, or any type of  
20 personal/variable data discussed herein. . For example, textual data may include, but is not limited to, the name, address, state, or privileges of the holder of the document. Graphical data may include, but is not limited to, such items as a photographic image of the holder (in black and white, grayscale, or color) of the information bearing document, the seal of the state or corporation issuing the document, a trademark, or other security such as a complex geometric pattern.

25 One of ordinary skill in the art will appreciate that information 118 other than security images could be similarly provided on any surface on information-bearing inner layer 106 or outer layers 102 and 108. In addition, information could also be provided on either adhesive layer 110 and 112. Similarly, one of ordinary skill in the art will appreciate, in light of the teachings provided herein, that the information on certain of these surfaces would require the information to be printed using a reverse format. Further, one of  
30 skill in the art will appreciate that the information 118 could be distributed among a plurality of layers that lie beneath the lenticular lens layer 116. Thus, this disclosure is not intended to be limited to providing the information in a particular orientation or to a particular surface.

35 In addition, the information may be provided on the desired surface using any known techniques. For example, affixing the information could include any process in which a marking material is applied to a substrate to generate a permanent mark. Thus, one skilled in the art will appreciate that the invention can be adapted for color and/or black and white printing techniques, such as photogravure, flexographic and lithographic printing, printing by means of ink jet printers (using solid or liquid inks), phase change

printers, laser printing, laser engraving and electro photographic printing. For example, laser engraved information could be provided on surface 104 of inner information-bearing layer 106 creating another level of security. Persons skilled in the printing art will appreciate that with some of these printing techniques, the "inks" used need not necessarily be conventional liquid inks but also could be solid phase change inks, 5 solid colors, dyes, etc. This disclosure is intended to include any means of affixing the information to a particular desired surface.

The optimal dimensions of the lenticular lens formed by the laminate 102 and its lenticules 116a-116n for viewing the information 118 are at least in part dependent on and adapted to suit the thickness of the laminate layer 102, the thickness of the information printed 118, and the expected focal length with 10 which the information 118 is to be viewed. For example, in an embodiment of the invention having a standard 30 mil thick identification card with D2T2 printing of variable information to a TESLIN core, which is to be viewed by a human at a distance of about one to two feet, the focal length is about 0.015 inches and depends on the distance between the edge of the lenticular lens and the information 118 printed on the core. In FIG. 4, the range of distances to consider is illustrated as "A" and "B" range from about 10 15 to 20 thousandths of an inch.

The number of lenticules 116 per inch ranges, in at least one embodiment of the invention, between about 45 to 100 lines per inch. As those skilled in the art will appreciate, the number of lenticules 116 required depends at least in part on the resultant size of the multiple image feature to be created, the 20 number of images being interlaced to form it, and/or the desired "flipping" (e.g., gradual or quick) between and among the multiple images.

The lens 116 is preferably transparent at least where the underlying information 118 can be viewed. Underlying information 118 can be any information printed on the information bearing layer 106 or on any layers disposed between the information bearing layer 106 and the lens 116. Therefore, each 25 document can be personalized for the cardholder. As is understood by those skilled in the art, the design of the lens 116 dictates the degree of rotation the ID card 100 needs for viewing the information. By rotating the ID card 100, the first and second security images 130, 130' appear to a viewer to appear and disappear.

In one embodiment, lens 16a is designed to require a rotation of the ID card 100 to order to view the underlying information. Rotating the ID card 100 causes the underlying information to seem to appear 30 and disappear as viewed through the lens 116, as shown in FIGs. 5 and 6. As will be described herein, the technique of printing the interlaced image on the information bearing layer 106 (e.g., a core layer in an identification card) instead of on the lens (formed by the laminate layer 102 and lenticules 116), enables the interlaced image to be printed with variable color information, if desired.

The lenticules 116 of FIG. 4 can be achieved in several ways, including by embossing the laminate 35 material 102 after it is laminated to the information bearing layer 106 (which is described more fully in FIGS. 11-17), and by using a purchased lenticular lens sheet, such as one provided by Orasee Corporation of Duluth, Georgia. The lenticules 116 can be achieved with any optical thermoplastic material including

but not limited to polycarbonate, polyester, polyurethane, cellulose acetates, polystyrenes, polyvinyl chloride, and polyethylene. In at least one embodiment, the embossing process does not induce any crystallinity or marring of the surface. Some polyester materials show low levels of crystallinity during the embossing process. Generally, this can be overcome by processing conditions, but if crystallinity ensues  
5 the optical properties could be sacrificed by the reduction in transmission. Advantageously, the outer layers 102 and 114 are substantially optically clear within the visible spectrum. A suitable material is an amorphous polyethylene terephthalate (also referred to as "PET") sheet 34, for example, the PET sheet sold by Transilwrap, of Franklin Park, IL under the trade name "TXP." In general, PET material has good strength and flexibility and has high anti-abrasion properties. Other suitable materials include like  
10 polyesters, which are the reaction products of the polymerization of ethylene glycols with polycarboxylic acids.

For adhesive layers 104 and 108, in at least one embodiment of the invention a usable adhesive material is an ethylene-vinyl acetate adhesive such as KRTY, which is the commercial trade designation for an adhesive available from Transilwrap. Other heat- or pressure-activated adhesive can of course be  
15 utilized, the selection thereof depending on the nature of the processes by which the inner-information bearing layer 106 is to be coupled to the outer protective layers 102 and 114. For a heat-activated adhesive, one can employ an ethylene ethyl acrylate copolymer of an ethylene ethyl acrylate or mixture thereof, as well as any of a number of polyolefinic hot melts.

FIGs. 7A-B are illustrative examples of a first security image, in original and pre-interlaced form,  
20 respectively, relevant to the creation of a multiple image security feature shown in the ID document of FIG. 3. FIG. 7A shows a first security image 130 (the cross hatches shown are for illustrative purposes and do not necessarily represent what is shown in an image) before interlacing. FIG. 7B illustrates what is here termed a pre-interlaced first security image 132, representing the portion of first security image that is to be interlaced. The pre-interlaced first security image 132 is not necessarily an image that is separately created.  
25 Rather, the pre-interlaced first security image 132 represents one example showing the parts of the first security image 130 that could be used to create an interlace image that could be placed as information 118 on an ID card 100 that is viewable through the lenticules 116 affixed to the card (See FIGs. 3-6)..

FIGs. 8A-8B are illustrative examples of a second security image 130', in original and pre-interlaced form, respectively, relevant to the creation of a multiple image security feature shown in the ID  
30 document of FIG. 3. FIG. 8B is similar to FIG. 7B in that it illustrated a pre-interlaced second security image 132', representing the portion of the second security image that is to be interlaced. The pre-interlaced second security image 132' is not necessarily an image that is separately created. Rather, the pre-interlaced second security image 132' represents one example showing the parts of the second security image 130' that could be used to create an interlace image that could be placed as information 118 on an  
35 ID card 100 that is viewable through the lenticules 116 affixed to the card (See FIGs. 3-6)..

FIG. 9 is an illustrative example of a multiple image security feature created by interlacing the first and second security images of FIGs. 7A, 7B, 8A, and 8B, in accordance with one embodiment of the

invention, in the manner contemplated by the flow chart of FIG. 10, which is now described.

FIG. 10 is an illustrative flow chart showing a method for creating the multiple image security feature 120 of FIG. 9, in accordance with one embodiment of the invention. Although this flow chart describes the process for creating a multiple image security feature 120 that is made from two security images, those skilled in the art will appreciate that this method readily can be adapted to interlace more than two images. In addition, although the term "security image" is used in this discussion by way of example, it is not limited to including just image type files, but also characters/strings.

In step 200, the desired first and second security images are received (step 200) for this process. The security image can be virtually any type of image or data. For example, in at least one embodiment, the security image is a string of one or more characters, such as a birthdate. The string can be in any font or color, and can include fixed and/or variable information. The string can be supplied in many ways, such as from a database, entered by hand, or extracted from a file.

In at least one embodiment, the security image is part of an image that was captured from a subject, such as a facial portrait, a fingerprint, or a signature. For example, in at least one embodiment, several pieces of such information about a subject can be stored in an object file that is usable as a security image input. In one embodiment, the method of FIG. 10 receives information in the form of a personal object file called a .poff file (formerly known as a POLAROID object file). The following provide some further information about the .poff file format used in accordance with at least some embodiments of the invention

#### 20 POFF FILES

This file format is designed to encapsulate all the data needed to process an individual ID card. All the data needed to print and handle the card will be included in the file. This permits this file to be shipped as an entity across a network where it can be printed, displayed or verified without need for additional information. The specific fields and their order in text area are not specified, there is a provision for a separate block of labels for the fields for display purposes. The format is suitable for encoding on 'smart cards' as well as transmission and printing of the records.

The image file formats were chosen for their compatibility with the AAMVA standards and for their widespread acceptance as file formats in popular applications and libraries.

30

#### Notes:

AAMVA (American Association of Motor Vehicle Administrators) has begun work on a transmission standard for Image/Text data and is revising its best practices guide for image storage format.

35 This format may have to be revised to conform with this new standard.

The AAMVA baseline standard for signatures is currently 8 bit grayscale (JPEG compressed), the standard also supports bi-level with CCITT group 3 or 4 as an accepted alternate. It needs to be determined which of these formats is preferred by the marketplace.

5 Typical US DMV Files Contain the Following blocks

- Text Block (tag 0x0001)
- JPG Portrait Block (tag 0x0011 or tag 0x0211)
- ID-3000 or TIF Signature Block (tag 0x0420 or 0x0520)
- They may optionally include fingerprint blocks

10

File Format

Header

|    |              |   |
|----|--------------|---|
|    | POFF         | 4 byte literal  |
| 15 | Version      | 2 byte unsigned integer<br>(high byte major version low byte minor version) |
|    | Object Count | 2 byte unsigned integer   |
|    | File Length  | 4 byte unsigned integer   |

**Directory Area**

|   |                    |  |
|---|--------------------|--|
|   | Directory Checksum | 4 byte unsigned integer                          |
|   | Object Type Tag    | 2 byte unsigned integer [Beginning of directory] |
|   | Length of Object   | 4 byte unsigned integer                          |
| 5 | Offset of Object   | 4 byte unsigned integer [from beginning of file] |
|   | ...                | additional directory entries                     |
|   |                    | <b>End of Directory Tag</b>                      |

**Data Area**

|    |                 |  |
|----|-----------------|--|
|    | Object Type Tag | 2 bytes [Included in length of object] |
| 10 | Object Checksum | 4 bytes                                |
|    | Object Data     |  |
|    | ...             | additional data sections               |

Checksums are the 32 bit unsigned integer sums of all the bytes in the checksum range, for data sections  
 15 the checksum range is all the bytes that follow the checksum until the next object tag, for the directory area  
 the checksum range is all the individual directory entries (the length should be 6 times the object object  
 count). The length in the header is the length of the original data object (it does not include the tag an the  
 checksum).

**20 Standard DMV File Layout**

- Header
- Directory
- Text Data
- Portrait
- 25 Signature

**Data Formats**

All numeric values are in Intel x86 format (byte order)

**30 Color Images**

- Primary Format
  - .JPG (JPEG File Interchange Format)

**Alternate Formats**

- .TIF (JPEG Compressed TIFF)
- 35 ID-3000 Version 2.2+ Compatible format with marker codes

**B+W Images**

- .PCX (CCITT Group 3 or 4 Compatible Modes)
- .JPG (8 bit grayscale JFIF compressed)
- .TIF (Any B&W or Grayscale TIFF 6 Compatible File Format)

5    **Text Data (or labels)**

- .CSV (comma separated value)
- A comma as data is represented by ESC , or by single quoting field
- Two commas together indicates a blank field
- All other characters must be printable ASCII Text (32-126,128-254)

10

**Data Tags**    (16 Bit Unsigned Integer)

|    |                         |        |                                     |
|----|-------------------------|--------|-------------------------------------|
|    | Text                    | 0x0001 |                                     |
|    | Text Field Labels       | 0x0002 |                                     |
|    | Double Byte Text        | 0x0101 | (for use with Asian character sets) |
| 15 | Double Byte Labels      | 0x0102 | (for use with Asian character sets) |
|    | Front Portrait          | 0x0011 | JFIF (JPG File format)              |
|    | Left View Portrait      | 0x0012 | JFIF (JPG File format)              |
|    | Right View Portrait     | 0x0013 | JFIF (JPG File format)              |
|    | Front Portrait          | 0x0111 | TIFF                                |
| 20 | Left View Portrait      | 0x0112 | TIFF                                |
|    | Right View Portrait     | 0x0113 | TIFF                                |
|    | Front Portrait          | 0x0211 | ID-3000                             |
|    | Left View Portrait      | 0x0212 | ID-3000                             |
|    | Right View Portrait     | 0x0213 | ID-3000                             |
| 25 | Signature               | 0x0020 | Bi-Level PCX (group 3 or 4)         |
|    | Signature               | 0x0120 | Grayscale (JFIF Compressed)         |
|    | Signature               | 0x0220 | Grayscale (JTIF Compressed)         |
|    | Signature               | 0x0320 | ID-3000 Grayscale                   |
|    | Signature               | 0x0420 | ID-3000 Binary                      |
| 30 | Signature               | 0x0520 | TIFF (any TIFF 6.0 type)            |
|    | Bitmap Fingerprint Data |        |                                     |
|    | Right Thumb             | 0x0030 |                                     |
|    | Right Index Finger      | 0x0031 |                                     |
|    | Right Middle Finger     | 0x0032 |                                     |
| 35 | Right Ring Finger       | 0x0033 |                                     |
|    | Right Little Finger     | 0x0034 |                                     |
|    | Left Thumb              | 0x0038 |                                     |

|    |                           |        |
|----|---------------------------|--------|
|    | Left Index Finger         | 0x0039 |
|    | Left Middle Finger        | 0x003A |
|    | Left Ring Finger          | 0x003B |
|    | Left Little Finger        | 0x003C |
| 5  | Minutiae Fingerprint Data |        |
|    | Right Thumb               | 0x0130 |
|    | Right Index Finger        | 0x0131 |
|    | Right Middle Finger       | 0x0132 |
|    | Right Ring Finger         | 0x0133 |
| 10 | Right Little Finger       | 0x0134 |
|    | Left Thumb                | 0x0138 |
|    | Left Index Finger         | 0x0139 |
|    | Left Middle Finger        | 0x013A |
|    | Left Ring Finger          | 0x013B |
| 15 | Left Little Finger        | 0x013C |
|    | Digital Signature Tags    |        |
|    | CRC Method                | 0x0040 |
|    | Polaroid Bingo Method     | 0x0041 |
|    | Datastream Tags           |        |
| 20 | PDF-417 Barcode Data      | 0x0050 |

|    |                       |                                     |
|----|-----------------------|-------------------------------------|
|    | End of Directory      | 0x00FF                              |
|    | User Definable Tags   | 0xFFxx (where xx is 0x00 - 0xFF)    |
| 25 | The Tag Pattern 0xFxx | is reserved for special operations. |

Notes on Tag Types

The Digital signature tags are for improved file security. The system is a compromise between encrypting the actual data elements, and leaving the data unsecured. A Digital signature object contains a 30 Digital Signature structure (defined elsewhere) that includes information about the specific object it protects. The original object is unchanged by the method, an application which wishes to validate the authenticity of an object builds the signature for the object and compares it to the value stored in the field.

The Datastream tags are used to represent data that is passed into the system for special purpose processing. They are used when the higher levels of the system do not have the ability to make sense of the data contained. An specific example of this would be when encrypted data is being passed in the system for printing as a barcode.

Now referring again to FIG. 10, virtually any type of pairing of different (or similar) types of files are possible with the pair of first and second security images. For example, in one embodiment, the first and second security images comprise a string (e.g., characters representing date of birth) and part of a personal object file, such a portrait image. In one embodiment, the first and second security images comprise a pair of personal object file data, such as a portrait and a signature. In at least one embodiment, the first and second security images comprise a personal object file data (e.g., a fingerprint image) and a standalone image, which could be a supplied image (e.g., a state seal or logo). Any of the information (strings, object files, images) can be fixed or variable, and those skilled in the art will appreciate that different types of cards will have differing security needs and, thus, may require different types of pairs of images.

Referring again to FIG. 10, if the first and second security images are not already in a predetermined standard size and bitmap form, the first and second security images are converted (step 205) to bitmap type files of a standard size. The size is dependent on the desired physical size of the multiple image feature on the card. In one embodiment, a software product usable to accomplish the conversion into a standard bitmapped image is the LEAD TOOLS 12.0 FOR WINDOWS 32 product available from Lead Technology, Inc., of Charlotte, North Carolina.

In step 210, an image row in the image is selected as a starting point to begin the interlacing. The image row can comprise of, for example a single row of pixels or can, for example, be multiple rows of pixels. The size of the image row depends on various factors, such as the design of the lens (e.g., lens dimensions), lens features (e.g., lenticules per inch), the size of the first security image, the size of the second security image, the degree of switching (fast or slow) between images that is desired, focal length, and surface quality.

For example, assume that a lenticular lens formed on the laminate 102 (FIG. 3) has about 90 lenticules (also referred to as "lines") per inch ("lpi"). It is assumed, for the purposes of this example, that the lenticules are oriented so that they are horizontally aligned over a security image, although such an orientation is not limiting. In this same embodiment, the first security image may have a size of 450 pixels long by 450 pixels wide, with each pixel (assume square pixels) being about 0.0011 inches along in length along each side—an image about a half inch long and a half inch wide. For an image with those dimensions and a lenticular lens formed in laminate 102 having 90 lenticules per inch (or 45 lenticules per half inch), there will be a lenticule about every 0.011 inches, or about every 10 pixels. Thus, one type of interlacing for the security image is to alternate every 10 pixels (e.g., 10 pixels "on" in the image, 10 pixels "off" for a first security image, and the reverse for the second security image). The inventors have determined, however, that the optimum interlacing for the security images used in ID documents is a 5 pixel on, 5 pixel off configuration. Referring again to step 210 of FIG. 10, the so-called row size would, in this example, be 10 pixels.

To determine a starting image row (that is, the row in the image where the method begins will

begin the "on-off" interlacing, the method of FIG. 10 uses a one or more predetermined input parameters. In one embodiment, a user may have a choice, for example, of setting the interlacing to begin at the top of an image and work down, at the bottom and work up, somewhere in between and work up or down. This is, in one embodiment, a fixed parameter for all identification documents being manufactured in a given 5 "batch" for example.

It is anticipated that the invention can be adapted to be able to determine the starting image row dynamically, based on the type and/or size of the first and/or second security images. For example, assume that the first security image is a full color image portrait having a first size and the second security image is a text string that can vary from user to user (e.g., an address) and thus may have a different "height" for 10 different users (assuming that the text string could "wrap around" to fill the available image space. The method of FIG. 10 and particularly step 210 can be adapted to select a starting row for interlacing depending on the "height" of the second security image, to best provide a substantially complete interlacing between the first and second security images. Note also that varying the starting row can cause the image flip angle (or the viewable angle) to change.

15 Although not specifically addressed in the example discussed in connection with FIG. 10, step 210 of FIG. 10 also takes into account parameters such as desired size of resultant final interlaced image and desired fonts and font colors of any characters printed as part of final interlaced image. The font colors can include single colors, multiple colors, rainbows of colors, pearlescent colors, full colors, and the like, as desired.

20 In step 215 of FIG. 10, if the first and second images are the same size, the processing moves to step 230 (discussed below). Note that, in at least one embodiment, two images being the same "size" implies that the two images have the same height and width (in pixels). In this embodiment, if the first and second security images are not the same size, the interlaced image is created in a different file, but if the first and second images are the same size, the interlaced image is created by directly interlacing into one of 25 the images (for purposes of example, we assume that image to be the first security image, but using the second works equally well). Generally, for images of unequal size, the smaller image is interlaced into the larger image.

If the first and second security images are different sized, an interlace file is defined (step 217) and the interlaced data is written to it from the first and second security images. The interlace file has a bitmap 30 format. This begins by writing the desired starting image row from the first security image to the interlace file (step 220). For example, if the first security image corresponded to the 450 by 450 example described above, the starting image row could be the first 10 rows of pixels in the first security image. Next, the desired starting image row (also, in this example, 10 rows of pixels) is written from the second security image (step 225). In one embodiment, this row is written in the interlace file to position directly adjacent 35 to the row just written from the first security image. As shown in steps 225, 230, and 235 this process is alternated back and forth from the first to the second security image until the desired amount of interlacing is complete or one of the images "runs out" of rows of pixels. Note that the method of FIG. 10 can be

adapted so that only partial interlacing (e.g., interlacing for, say, 40 lenticules worth of image) is required, so the process of steps 225 through 235 can stop when the desired amount of interlacing is desired.

If one of the images is out of rows, the rows in the other image continue to be written to the interlace file, alternating with rows of "blanks", until there are either no rows of the image left or the 5 desired interlacing is complete (step 240). In this embodiment, by "blank" it is meant that the other image will be overwritten with whatever background color (e.g., white, but need not be white) that the information bearing layer 106 is. The interlaced image file is then complete (step 245) and ready to be provided to a printer for printing on a card (step 250). In at least one embodiment, the resultant interlaced image file resembles the file shown in FIG. 9.

10 Referring again to step 215, if the first and second security images are the same size, it is not required to create a new interlaced image file (although in at least one embodiment it is contemplated that a new interlaced image file nonetheless can be created in a manner similar to that described in steps 217 through 250). Rather, one of the security images can be "turned into" an interlaced image file via steps 255 through 250. For purposes of example only, it is assumed here that the first security image is to be "turned 15 into" the interlaced image file.

The starting image row in the first security image is retained (step 255) (note that starting image row and subsequent image rows are the same as defined above). The next image row in the first security image is overwritten with the starting image row from the second security image (step 260). This process continues (alternately overwriting the image rows in the first security image) until the desired degree of 20 interlacing is achieved or all rows are interlaced (step 265). The resultant interlaced image will have a similar general appearance to the image of FIG. 9, but will show interlacing of two similarly sized images. As a result of steps 255 through 265, the first security image file has been converted to an interlaced image file (steps 270 and 275) and is ready to be printed on the substrate.

It will be appreciated by those of ordinary skill in the art that several print technologies including 25 but not limited to indigo (variable offset) laser xerography (variable printing), offset printing (fixed printing) and inkjet (variable printing) can be used to print the information 118 (which can include the above mentioned interlaced image file) on the inner information-bearing layer 106. The information can be printed using dots or lines of varying colors to form text or images. The information also can comprise process colors or pantone colors. The multiple image features can include personal information in a color 30 format.

In one embodiment of the invention, the ID card 100 of FIG. 3 can be produced in a high volume central issue environment. FIG. 11 is an illustrative diagram of a first central issue card production system 500 that can be used to produce the ID document of FIG. 3, in accordance with one embodiment of the invention. The system 500 includes an imaging system 505, laminator and die cutter system 504, and a 35 document production and control system 506.

The imaging system includes a back printer 508 for printing the back side of the card and a front printer 510 for printing the front side of the card. Each printer has its own high speed controller 514, 515.

The laminate and die cutter system 504 includes a laminator 522, an embosser 524, a die cutter 558, and a laminator/die cutter/embosser controller 553. In one embodiment, the laminator/die cutter/embosser controller helps to implement the method of FIG. 10.

The document production control system includes central servers 540, a report station 534, a

- 5 quality control station 536, and a mailer 530. The QC Station 536 and its associated bar code scanner (not shown) can be used by an operator to scan the bar code of a defective sheet or document. Keyboard entry can also be used to report or to check documents and sheets.

Production of the ID document begins at the Imaging System 505, where card substrates, such as preprinted TESLIN sheets 516, are fed into the back printer 508. The back sides of the TESLIN sheets 516 10 can be customized with desired information (e.g., restriction codes or other information unique to each document on the sheet). In addition, bar codes for tracking the documents through the production process can be added. As the TESLIN sheet enters the second section of the Imaging System 505, the front printer 510 prints appropriate portrait and signature images on the front of the documents based on personalized cardholder information stored in a file. The front printer 510 also prints the interlaced images (which, in 15 one embodiment, comes from an interlaced image file accessible to the laminator/die cutter/embosser controller 553) on the front of the TESLIN sheets 516. Note that since a plurality of ID documents are being produced simultaneously, the front printer 510 can print an interlaced image file for each document onto the appropriate locations of the TESLIN sheets 516. The output of the front printer 510 are document sheets 550 printed on the front and back.

20 As completed sheets accumulate in the output hopper of the Imaging System 505, in one embodiment, an operator performs a visual inspection and transfers the completed sheets to the input hopper of the Laminating/Embossing/Die-Cutting System 504. Any sheets failing visual inspection can be brought to the QC station 536 where their bar code is scanned and production of a replacement automatically ordered. The failed sheets are then destroyed.

25 When the document sheets 550 are about to enter the Laminating/Embossing/ Die-Cutting System 504, automatic scanners confirm that the front and back sheets 550 match, that sheets 550 have not stuck together, and that the sheets 550 are right side up. After the scanning process, the laminator 522 applies the desired laminate material (e.g., polyester) on both sides (front and back) material to all sheets to form a continuous web of laminated sheets. The embosser 524 then embosses the laminate to form the lenticles 30 116 (FIG. 3). In at least one embodiment, registration marks printed on one or both sides of the sheets 550 help to precisely orient the embosser 524 so that the lenticular lens feature is correctly formed on the interlaced images 120 printed on the sheets 550. More details about the embosser 524 are provided below.

35 The web of laminated sheets leaves the embosser then passes into the die cutter 558, which cuts the sheet into individual documents. After the ID documents are produced and given a final quality control inspection, they are fed into the mailer 530. The mailer prints the applicant's address on the card holder and inserts the ID document into the holder. The holder is then inserted into an envelope for mailing

FIG. 12 is a detailed view of the section 526 of the embosser 524 of FIG. 11. This detailed view

shows that an embosser in accordance with one embodiment of the invention includes a plurality of lenticular dies 554, an insulator plate 544, and a heater bar 542 in the insulator plate. The heater bar 542 in the insulator plate helps to keep the die 554 laminate at a temperature suitable for the deformation necessary to produce lenticules during embossing.

5        Although not visible in FIG. 12, the embosser 524 is capable of up and down motion 548 to accomplish the embossing process (the techniques for doing this are not described here and assumed to be within the abilities of one skilled in the art). Various parameters, such as time, temperature, pressure, stroke of the press and die design, can be adapted to optimize the operation of embosser 524 for a given ID document, laminate, and lenticule size. For example, in one embodiment, when using polycarbonate  
10 materials, the embosser 524 uses a temperature of 425 degrees Fahrenheit for 5 seconds at a pressure of 20 PSIG (lb/in<sup>2</sup> on the gauge) is used. When using a PET material a temperature of 275 degrees Fahrenheit for 5 seconds and a pressure of 20 PSIG is used. The stroke of the press is set so that the die 554 only enters the surface of the laminate so as to emboss the lenticules. If the stroke is too large then the card deformation will be excessive. Stroke time and temperature are interrelated because of a minimum amount  
15 of heat is required to form the lenses 116. The higher the die 218 temperature the lower the time required to form the lens and vice versa. Pressure and stroke of the press 216 are adjusted to minimize card deformation. Deformation can occur throughout the ID card 100 thickness and show on the back of the card or at the edges of the card. By optimizing these adjustments, these effects are reduced to make an acceptable ID card 100.

20        The plurality of lenticular dies 554 enable the embossing of a corresponding plurality of ID documents that pass through in the ID document orientation direction 552. Specifically, each lenticular die 554 is capable of creating a plurality of lenticules on the laminate that covers each interlaced image printed on respective ID document. In the embodiment shown in FIG. 12, there are 7 lenticular dies 554 that can substantially simultaneously emboss 7 different ID documents that are part of the printed sheets 550. It  
25 will be appreciated, however, that the laminator 524 of FIGs. 11 and 12 also could be adapted to emboss a single ID document at a time (e.g., with no subsequent die cutting), or to emboss documents passed through in a form other than sheets to be die cut, such as a 1 by n web (where n is the number of ID documents) passing through the embosser 524.

FIGs 13A-D are illustrative top, cross-sectional, enlarged, and isometric views, respectively of the  
30 lenticular die 554 of the embosser of FIG. 11. The lenticular die 554 can be formed from many different materials, including metals, ceramics, composites, and the like.

The quality of the surface of die 554 can have a significant impact on the quality and "on off" effect of the lenticules that it forms. For instance, if a rough surface is generated from the manufacturing process of the embossing die 554, the rough surface could be transferred to the lenticular lens 116 and the  
35 functionality could suffer, accordingly. Note also that various machining processes can be used to create different depths of the sinusoidal patterns of the die 554 shown in FIG. 13(c). In one embodiment, an

electrical discharge machining (EDM) processes are used make the die 218 having a surface roughness of #16 or better.

In one embodiment, the resultant lenticules formed by the die 554 can be improved by electroplating the die 554 with various materials such as TEFLON, Polyond, Ni-plating, Cu plating or Cr-plating. As those skilled in the art will appreciate, the plating depends on the die material and the compatibility of the plating material.

In one embodiment the die 554 can be plated then coated over the plating with a polytetrafluoroethylene coating to reduce the adhesion of the die 554 to the laminate. Referring to FIGs. 3 and 13, the upper light-transmissive outer layers 102 material might require some mold release agents to prevent the die 218 from sticking to the ID card 100 after the embossing process. When the die 554, begins to ascend from the ID card 100 surface, the die 554 can adhere to the ID card 100, the ID card 100 and lens 116 will deform and produce a poor product. The level of mold release is a factor in formulating a material that would optimize this process. Exterior mold release agents can be used in conjunction with internal mold releases to improve the process. The type of exterior mold release will also have an effect.

For purposes of further illustration, FIGs. 14A-D are cross-sectional, perspective, side, and edge views, respectively, of the insulator plate of the embosser of FIG. 11, and FIGs. 15A-D are top, cross-sectional, edge, and perspective views, respectively, of the heater bar of the insulator plate of FIGs. 14A-D and FIG. 11. The insulator plate and heater bar can be formed of any suitable materials, including mild steel (CRS), glastherm, and high temperature insulating material.

FIG. 16 is a flow chart of a first method for manufacturing the ID document of FIG. 3 using the system of FIG. 11, in accordance with one embodiment of the invention. The detailed description of these method steps already has been done in connection with the description accompanying FIGs. 3, 10, 11, 12, and 13, and is not repeated here.

The above described embodiments were provided to illustrate one aspect of the invention, in which a multiple imaged ID document having a lenticular lens feature can be manufactured by laminating the ID document then embossing a lenticular lens into the laminate. It should be understood, however, that the invention is not limited solely to forming a lenticular lens after lamination in the above-described manner. Those skilled in the art will appreciate that lenticules can be formed after lamination in many different ways. For example, in at least some embodiments of the invention the lenticules 116 of the identification documents described herein can be created by physically removing some of the laminate to achieve the desired shape, such as by etching, engraving, milling, scratching, stamping, abrading, bending, filing, cutting, inscribing, and the like. The removal of the laminate can be done using any known tooling, through chemical processes (e.g., chemical etching) or by a laser. It also is contemplated that in at least some embodiments of the invention, a mold could be used to form the laminate into lenticules as the laminate is applied to the information bearing layer 106.

It is unclear at the time of filing whether roll laminates containing an extrusion formed lens or laminate with previously formed lenses and respective registration marks for later lamination processes to

form ID documents are available. However, the invention proposes a method to make such a roll laminate, below.

In another aspect of the invention, the formation of lenticules 116 on the laminate 102 occurs prior to the laminating of the laminate to the information bearing layer 106. For example, embossing of the 5 laminate 102 with lenticules can occur prior to lamination. In one embodiment, a multiple imaged ID document can be formed by using sheets of laminate having lenticular lenses already formed thereon. A separate process step can be used to form the lenticular lenses on the laminate. This embodiment of the invention can be achieved using a system similar to the system shown in FIG. 11. Instead of providing an embosser 524, however, a system of this aspect provides a roll of laminate material that includes lenticular 10 lenses formed thereon. Advantageously, the laminate having lenticular lenses formed thereon also includes registration marks within the laminate, to assist in accurately registering the lenticular lens to the interlaced image as the laminate is laminated to the image.

For example, FIG. 17 is a flow chart of a method for manufacturing the ID document of FIG. 3 in a central issue environment where the creation of lenticules on the laminate 103 occurs prior to lamination, 15 FIG. 18 is an illustrative diagram of a second central issue card production system 500' that can be used to produce the ID document of FIG. 3 in accordance with the method of FIG. 17, and FIG. 19 is an illustration of a portion of a laminate roll 800 showing laminate having lenticular lenses 116 formed thereon.

Referring to FIG. 17, laminate is provided (step 700). The laminate can be any laminate described 20 previously that also is capable of being formed into lenticules. As will be readily understood by those in the art, the laminate can be provided in any usable form, such as pellet, powder, hot melt, and the like. The laminate is extruded (step 703) in a manner known to those skilled in the art, and then the laminate is processed so that predetermined areas of the laminate have lenticular lens features (such as the lenticules 116 of FIGs. 3 and 4) formed thereon. In one embodiment, the processing of the laminate comprises using 25 one or more known processes to form or emboss the lenticular shapes into predetermined areas of the laminate, prior to the laminate being laminated to the card. Such processes can, for example include embossing rollers, vacuum drums, vacuum forming dies, in line corrugators and shapers, cutters, punches, etc., all of which are described, e.g., on pages 354-360 of Sidney Levy and James F. Carley, Plastics Extrusion Technology Handbook (2<sup>nd</sup> ed., New York, 1989). Further, one or more methods detailed in the 30 following U.S. patents also may be useable, in at least some embodiments of the invention, for forming the lenticules in the laminate: Patent Nos. 2,815,310, 3,496,263, 4,765,656, 5,560,799. The contents of these patents are incorporated by reference in their entirety. It also will be appreciated by those skilled in the art that prior to lamination to the card, certain laminates can have lenticules formed thereon by etching, engraving, milling, scratching, stamping, abrading, bending, filing, cutting, inscribing, and the like.

35 Referring again to FIG. 17, after the lens(es) are formed in the laminate, registration information is applied to the laminate (710), to ensure that the laminate is appropriately aligned to the information bearing document(s) to which it is attached. FIG. 19 is an illustration of a portion of a sheet of laminate roll 800

prior to step 715. In FIG. 19, it can be seen that a plurality of lenticular lenses 116 are formed in a registered fashion on the sheet of laminate 800. The sheet of laminate 800 in this example has been formed with divider lines 800 thereon, to further assist the later registration and lamination to the information bearing layer 106. The dotted lines 810 are provided for illustrative purposes only (these lines are not necessarily on the laminate) to show where the divisions between ID documents lie. A registration mark 812 is provided on one side of the laminate 800 also will assist when the laminate 800 is later coupled to the information bearing layer 106.

In at least one embodiment, the sheet of laminate 800 is part of a larger sheet of laminate that is eventually rolled (step 715) so that it can be used as the special laminate 559 of FIG. 18. Referring to FIGs. 17 and 18, when the documents 550 are fed to the laminator 522, the laminate is aligned so that each respective lenticular lens 116 is appropriately aligned to a corresponding multiple image feature on the information bearing layer 106. (step 720). The identification documents can then be laminated (step 725) and die cut (step 730) as described previously.

It should be understood that the lenticular multiple image information of at least some embodiments of the invention can be provided in any color, not only black. This is accomplished at least in part because the interlaced image is printed directly on the card and is produced using the original images. If the original images are in color then the interlaced image can have the same color replicated therein.

Having described and illustrated the principles of the technology with reference to specific implementations, it will be recognized that the technology can be implemented in many other, different, forms.

Although certain words, languages, phrases, terminology, and product brands have been used herein to describe the various features of the embodiments of the invention, their use is not intended as limiting. Use of a given word, phrase, language, terminology, or product brand is intended to include all grammatical, literal, scientific, technical, and functional equivalents. The terminology used herein is for the purpose of description and not limitation.

The technology disclosed herein can be used in combination with other technologies. Examples include the technology detailed in the following applications, the disclosures of which are incorporated herein by reference: 09/747,735 (filed 12/22/00), 09/969,200 (filed 10/2/01). Also, instead of ID documents, the inventive techniques can be employed with product tags, product packaging, business cards, bags, charts, maps, labels, etc., etc., particularly those items including engraving of an over-laminate structure. The term ID document is broadly defined herein to include these tags, labels, packaging, cards, etc. In addition, while some of the examples above are disclosed with specific core components, it is noted that laminates can be sensitized for use with other core components.

To provide a comprehensive disclosure without unduly lengthening the specification, applicant hereby incorporates by reference each of the patents and patent applications referenced above.

The particular combinations of elements and features in the above-detailed embodiments are exemplary only; the interchanging and substitution of these teachings with other teachings in this and the

incorporated-by-reference patents/applications are also expressly contemplated. As those skilled in the art will recognize, variations, modifications, and other implementations of what is described herein can occur to those of ordinary skill in the art without departing from the spirit and the scope of the invention as claimed. Accordingly, the foregoing description is by way of example only and is not intended as limiting.

- 5 The invention's scope is defined in the following claims and the equivalents thereto.

## CLAIMS

1. A method for making a secure ID card with multiple images comprising the steps of:
  - providing information on an information-bearing layer, the information constructed and arranged to be capable of providing multiple images when printed information is viewed at different predetermined angles through an appropriate lens;
  - covering at least a first portion of the information with a substantially transparent film material;
  - embossing a lens profile on at least a second portion of the film material, the embossing forming a lens on the film material, the lens enabling the information to display multiple images when the information-bearing laminar assembly is viewed at different predetermined angles.
2. The method of claim 1 wherein the information comprises information in at least one color.
3. The method of claim 1 wherein the information comprises a full color image.
4. The method of claim 1 wherein at least one of the multiple images comprises variable information.
5. The method of claim 1 wherein comprising providing information on the information bearing document comprises at least one of printing the information and laser engraving the information.
6. The method of claim 1 wherein the embossed lens profile comprises a lenticular lens.
7. The method of claim 1 further comprising laminating the information bearing layer with the film material.
8. An information bearing document having at least first side, the information bearing document comprising:
  - a core layer;
  - an interlaced image formed on the core layer, the interlaced image comprising at least two images constructed and arranged to provide at least two images when the interlaced image is viewed through a predetermined lenticular lens through at least two different predetermined angles; and
  - a lenticular lens operably coupled to at least a portion of the interlaced image, the lenticular lens constructed and arranged to be operable with the interlaced image to enable at least two images in the interlaced image to be viewable through the lenticular lens at two different angles.
9. The information bearing document of claim 8, wherein the interlaced image includes at least one image that comprises personalized information.

10. The information bearing document of claim 8, wherein the interlaced image includes at least one color image.

5 11. The information bearing document of claim 8, further comprising a laminate layer operably coupled to the core layer, wherein the lenticular lens is part of the laminate layer.

12. The information bearing document of claim 11, wherein the lenticular lens is formed into the laminate layer by embossing the lens onto the laminate layer.

10

13. The information bearing document of claim 8, wherein the interlaced image is formed such that the arrangement of the interlacing is dependent on at least one parameter associated with at least one of the two images being interlaced.

15

14. The information bearing document of claim 13, wherein the parameter comprises at least one of image type, image size, data type, lenticular lens size, lenticular lens arrangement, font size, font color, image color, image dimensions, and starting location for interlacing.

20

15. An information bearing document having at least first side, the information bearing document comprising:

a core layer; and

means for displaying at least two images on the core layer, the at least two images being selectively visible dependent on the angle of viewing of the information bearing document, wherein at least one of the two images comprises at least one of a color image and an image associated with personalized data.

25

16. The information bearing document of claim 15, wherein the means for displaying further comprises an interlaced image formed on the core layer and a lenticular lens affixed to the interlaced image, the interlaced image and lenticular lens cooperating to display the at least two images at two different angles of viewing.

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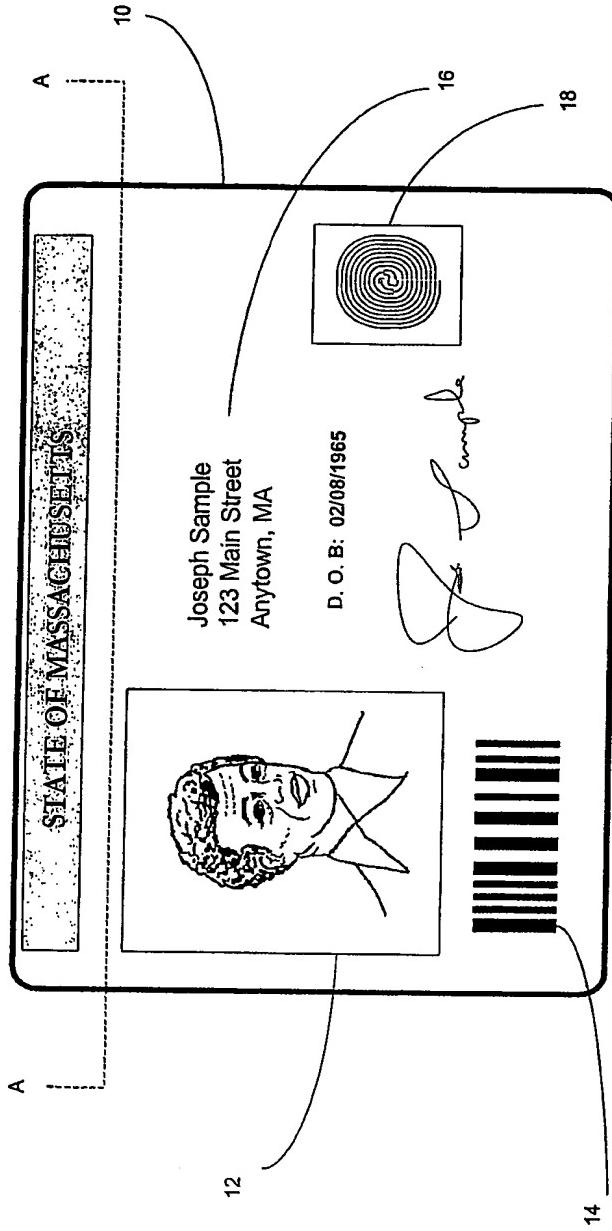


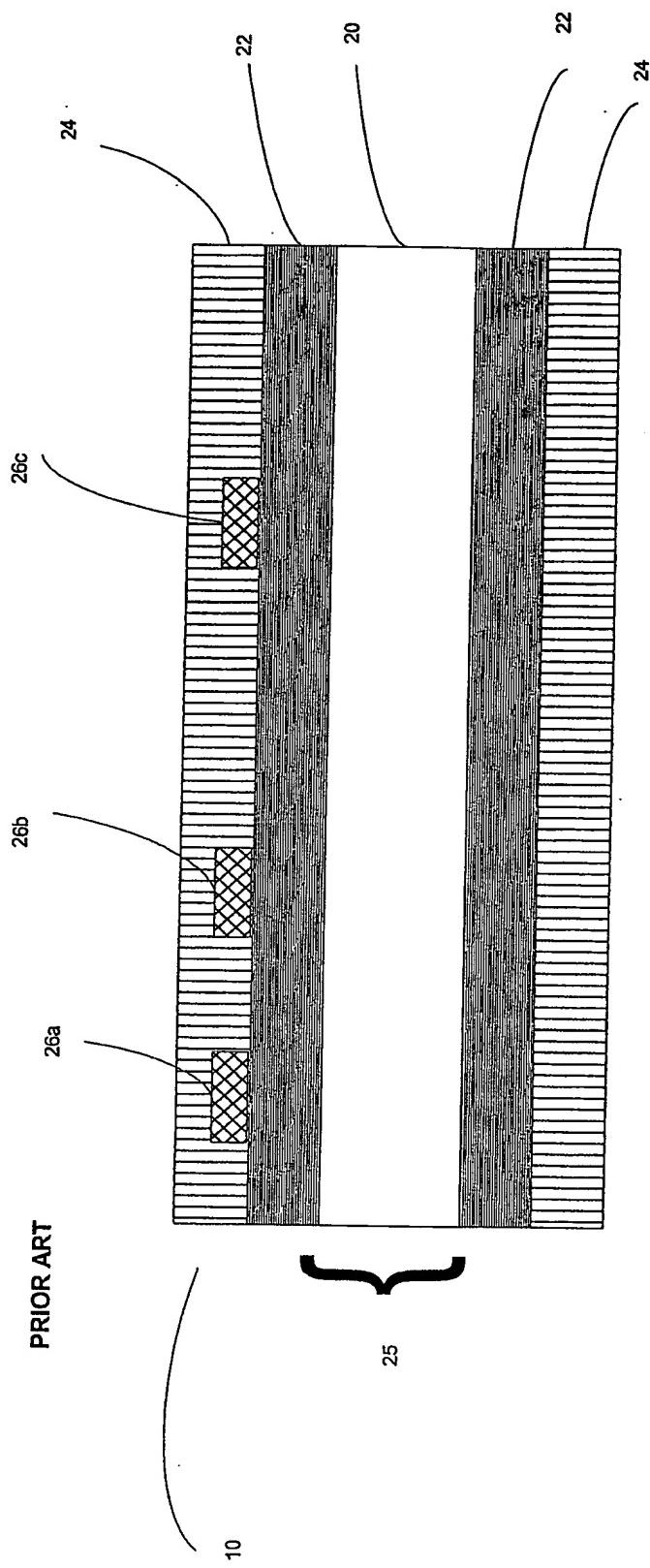
FIGURE 1

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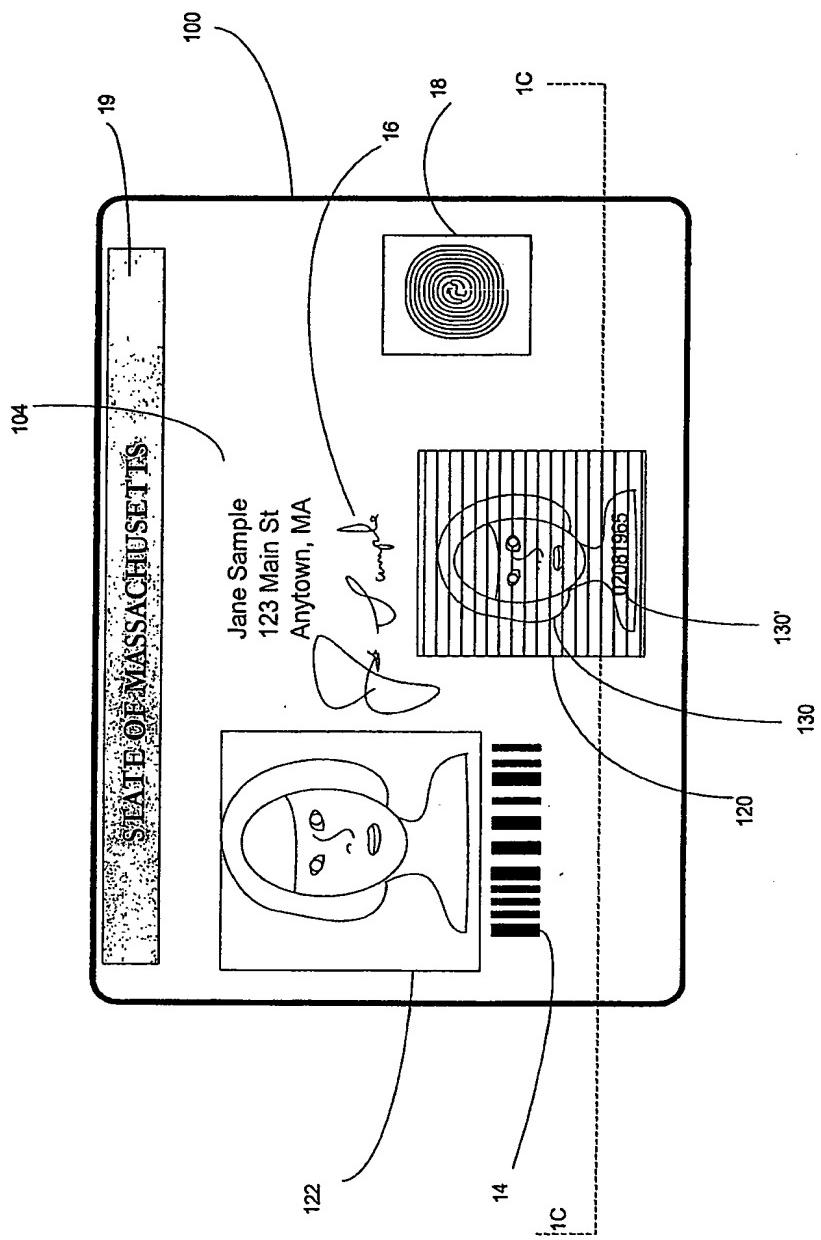
**FIGURE 2**

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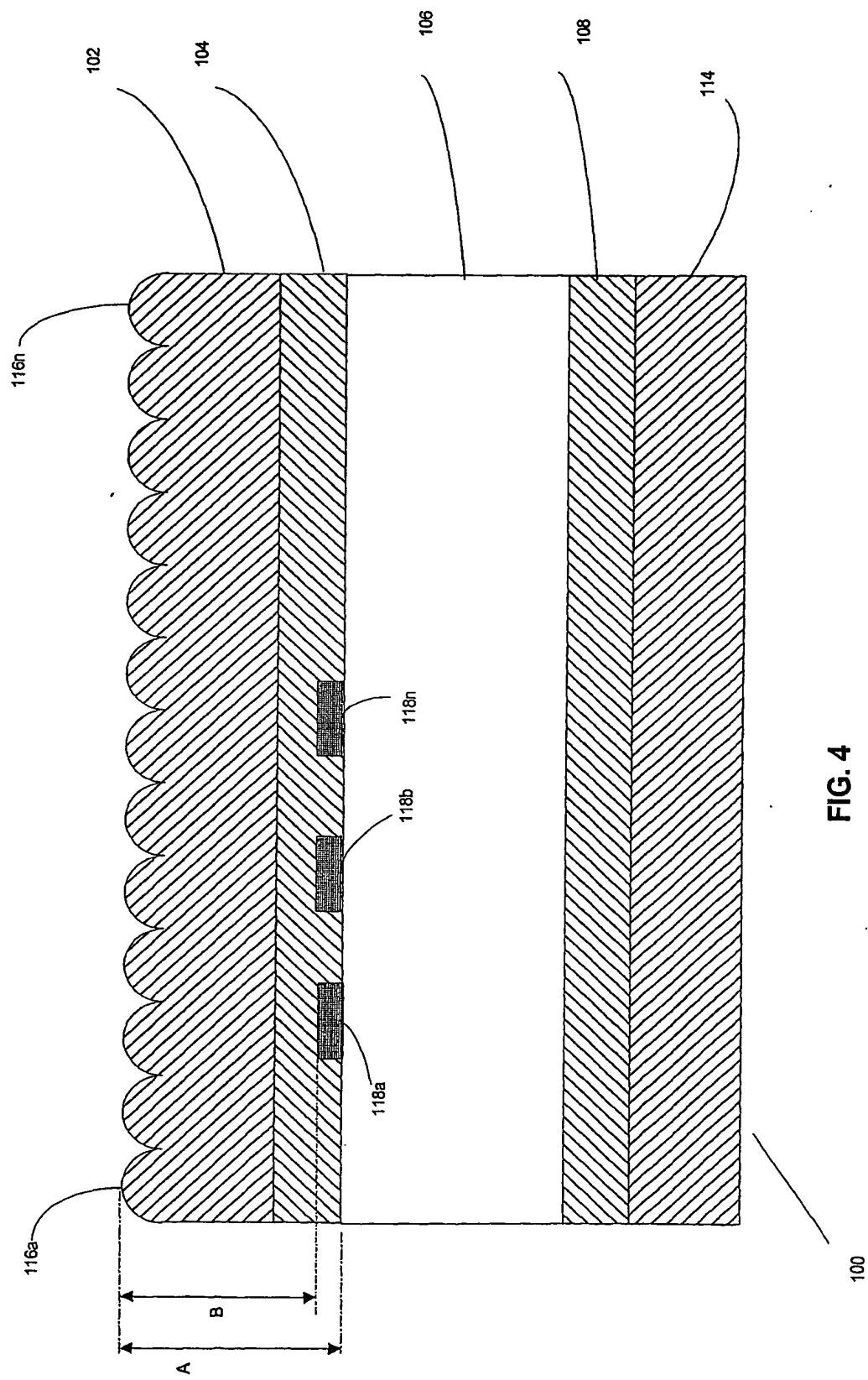
**FIG. 3**

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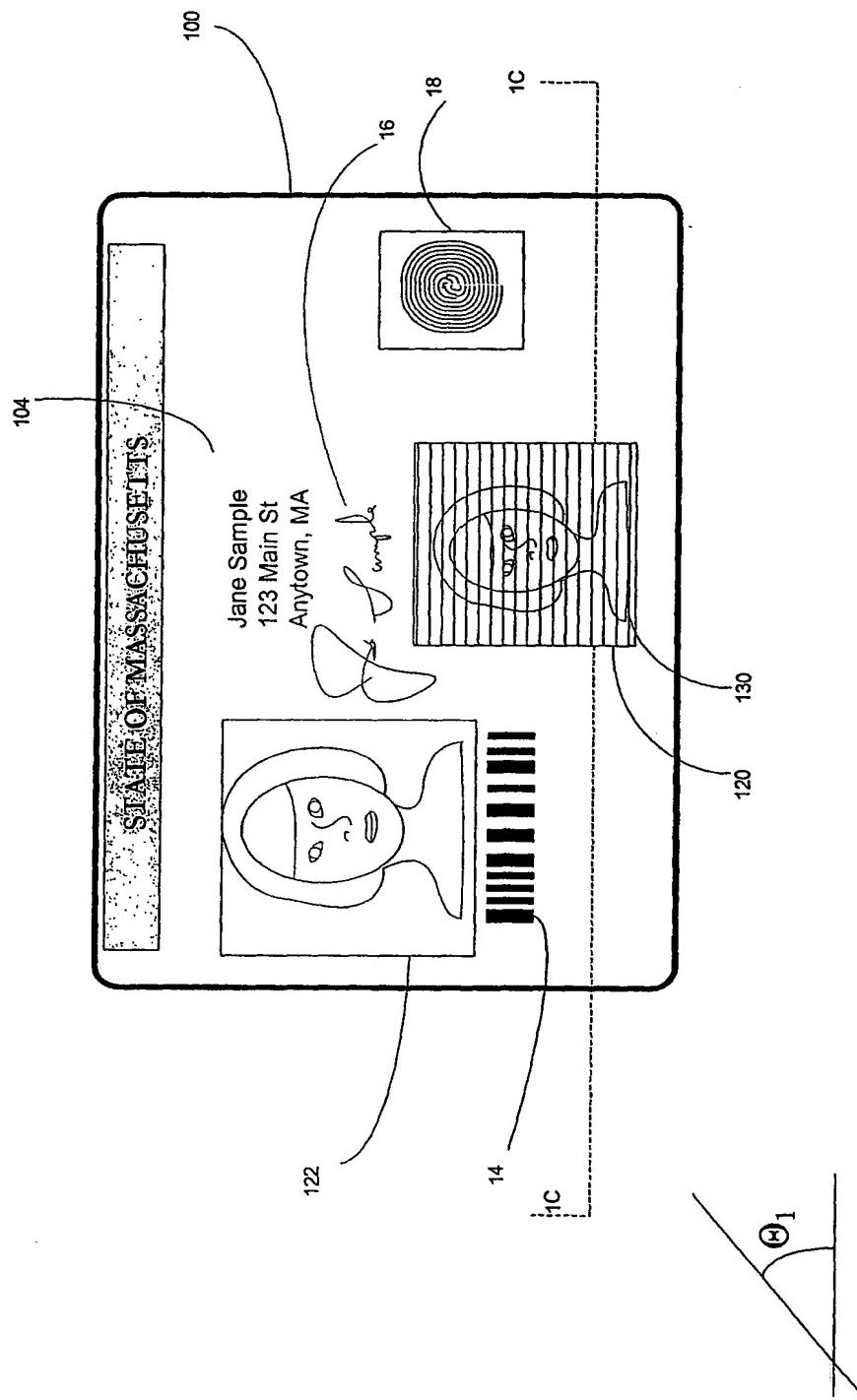
**FIG. 4**

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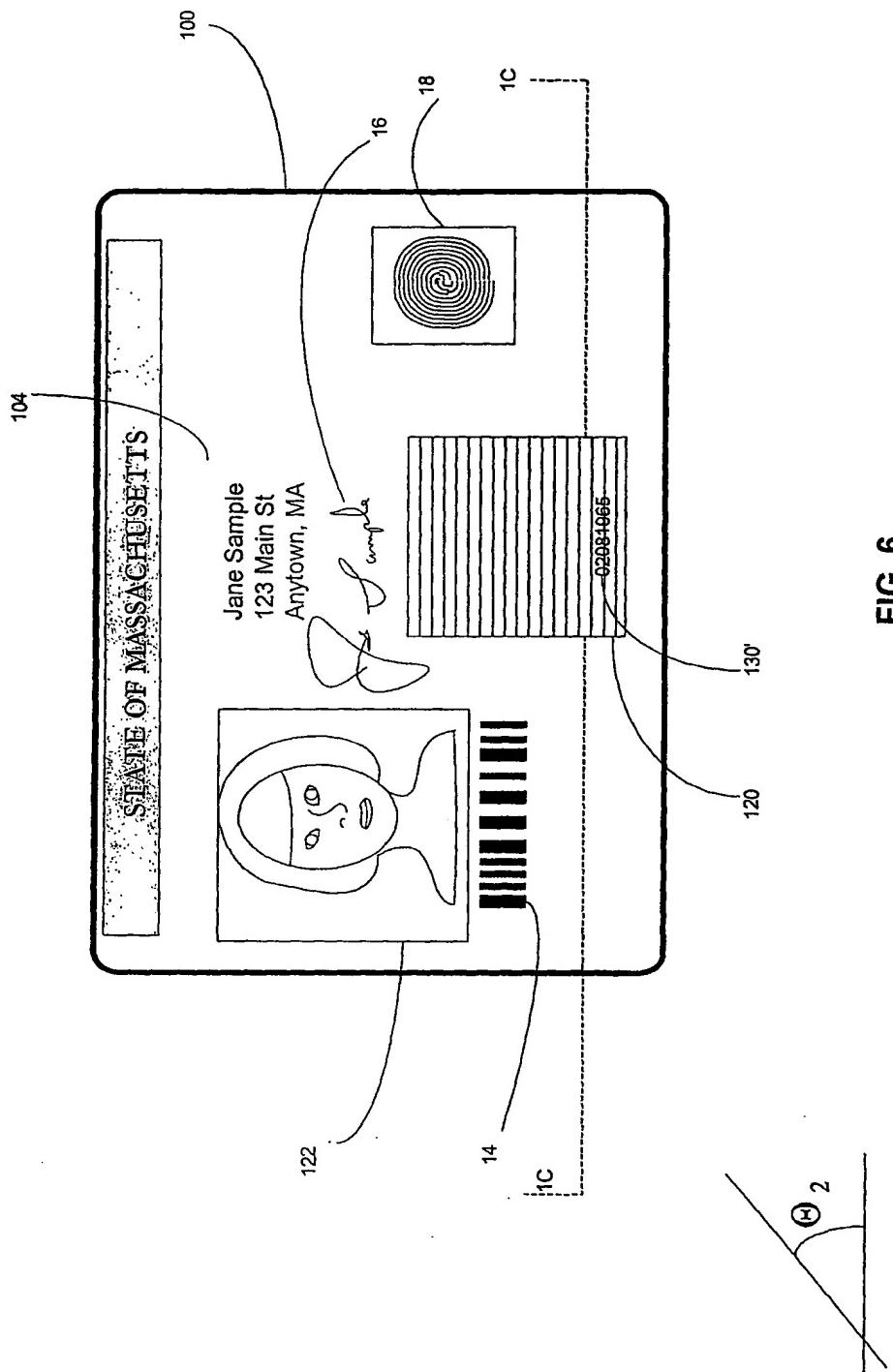
**FIG. 5**

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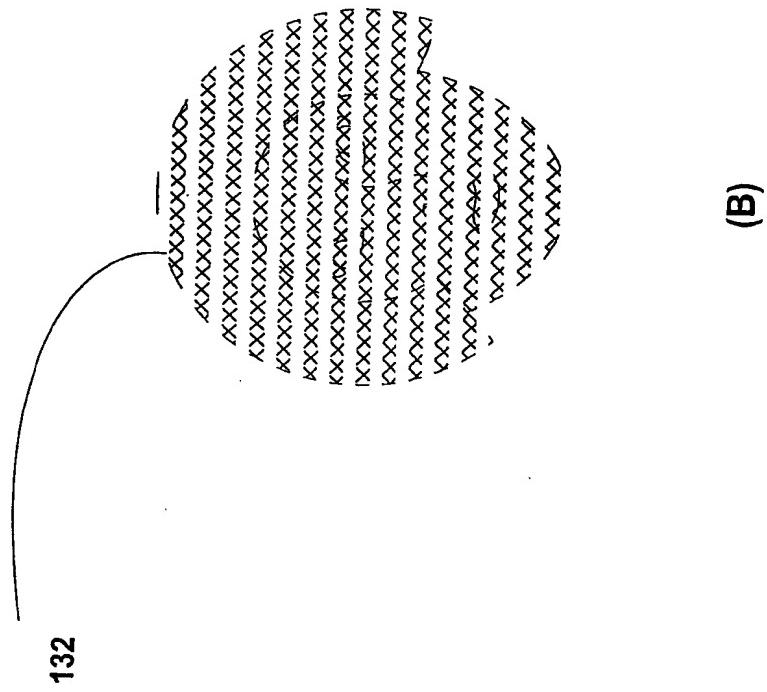
**FIG. 6**

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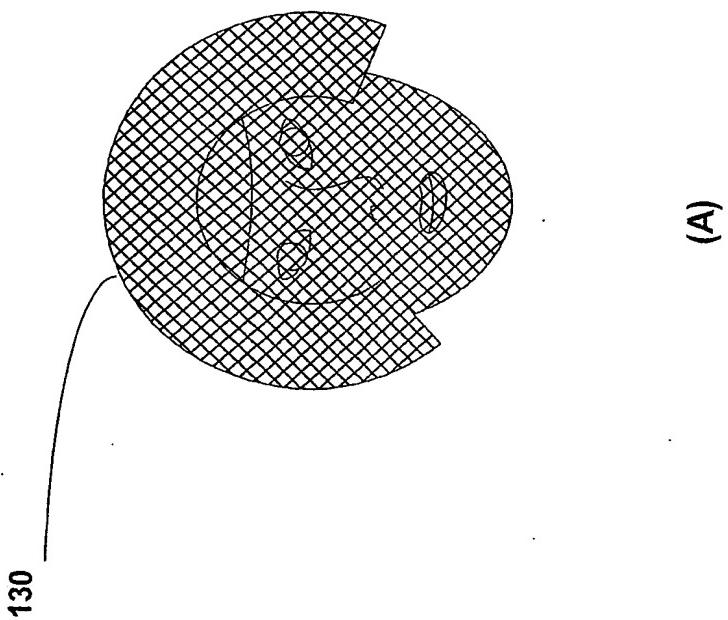
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132

(B)

FIG. 7



130

(A)

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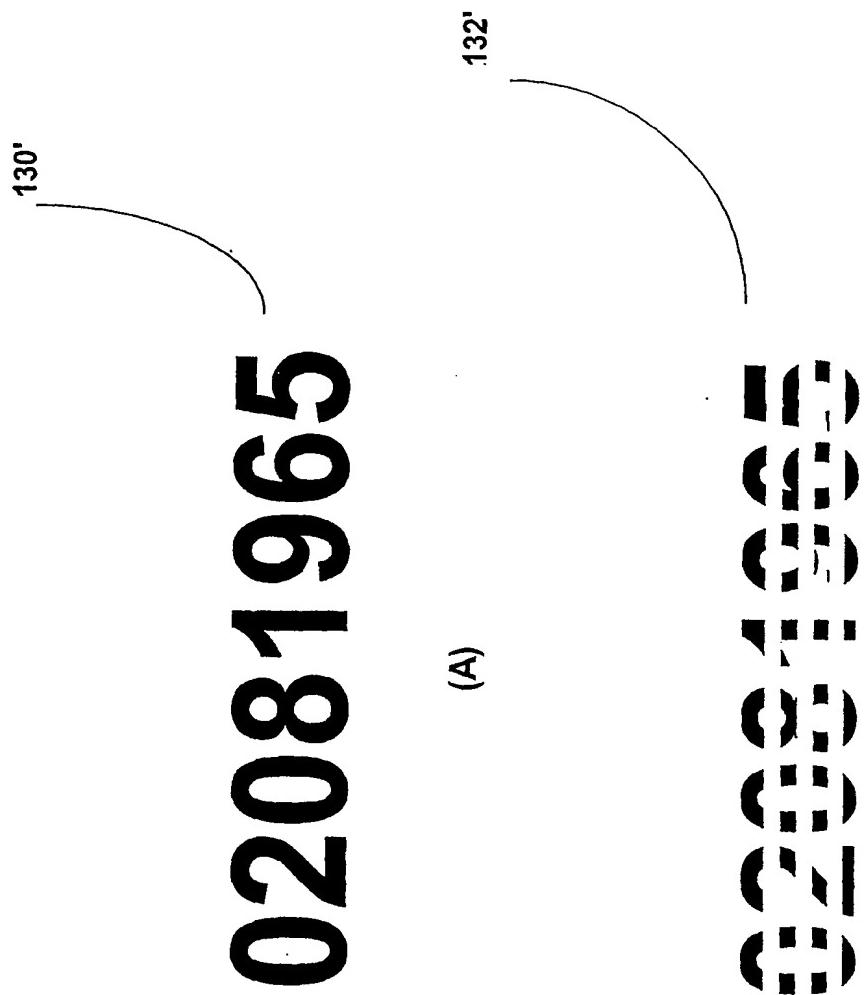


FIG. 8

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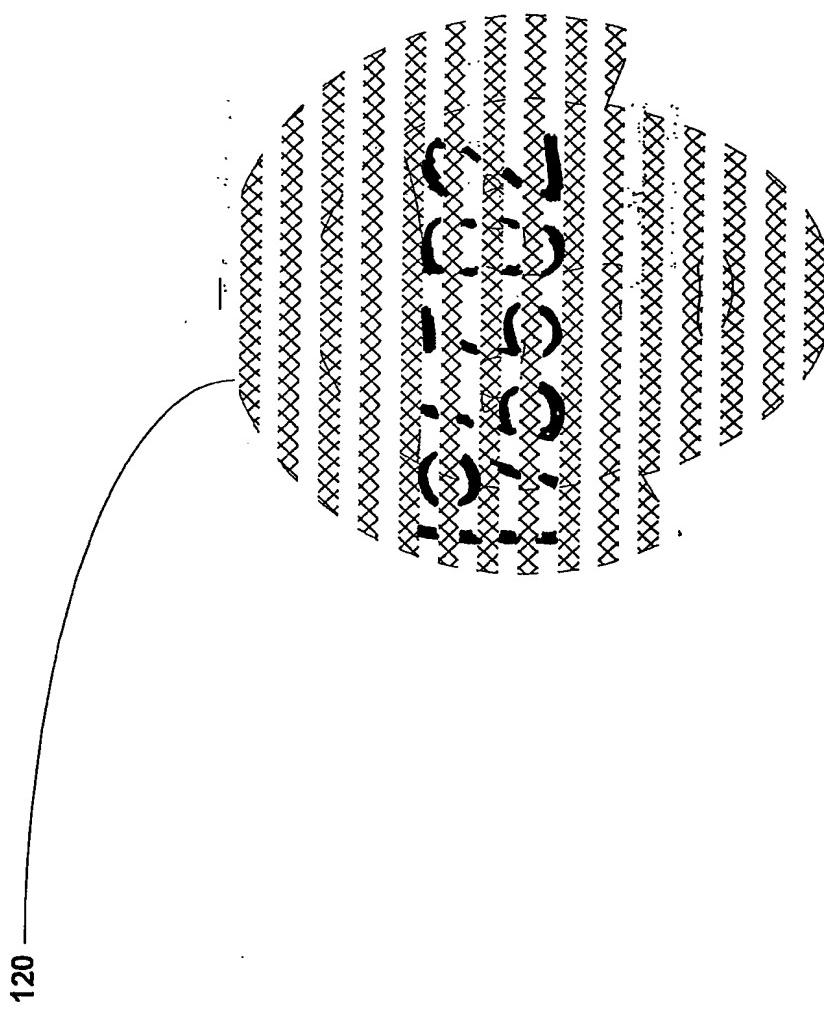


FIG. 9

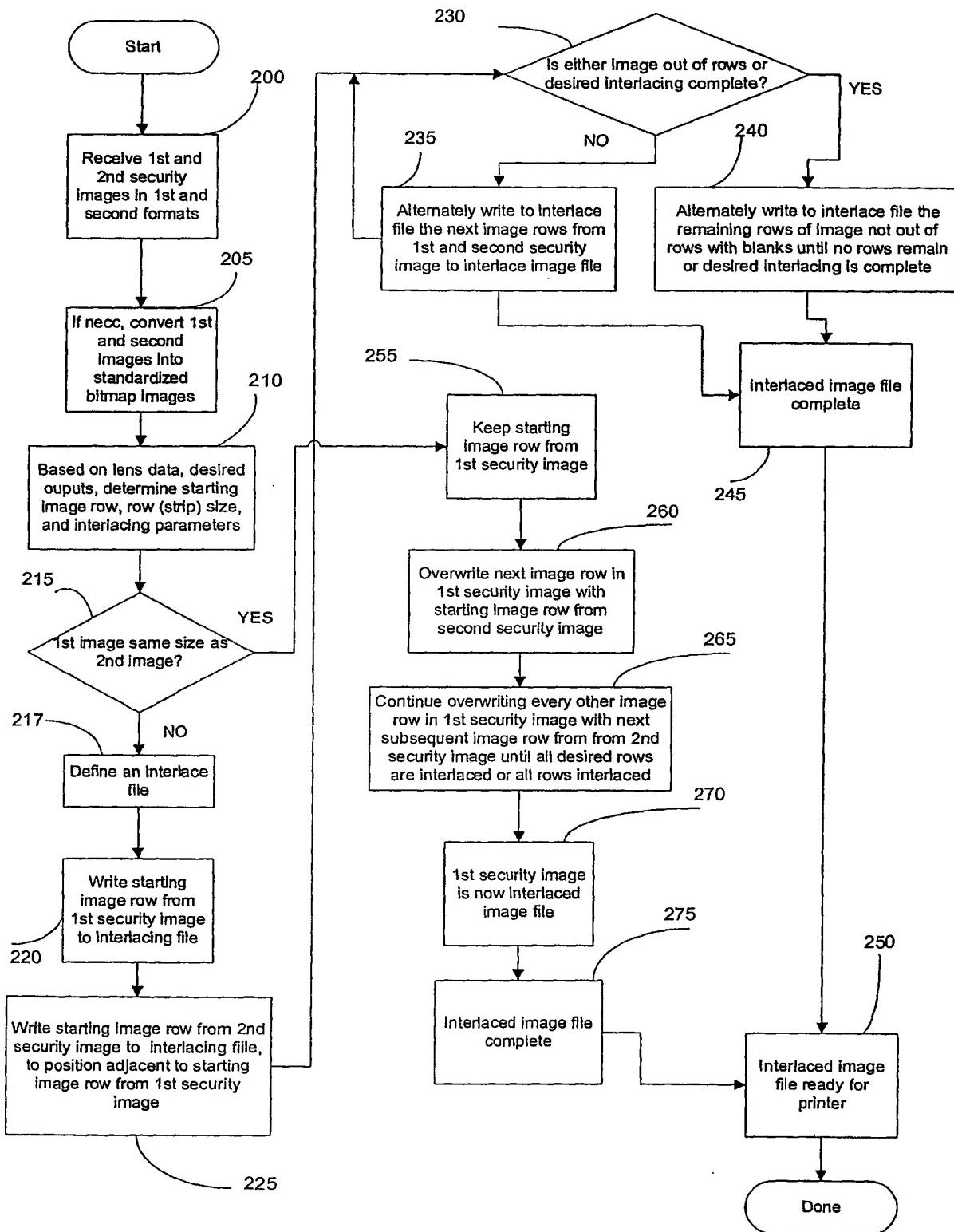


FIG. 10

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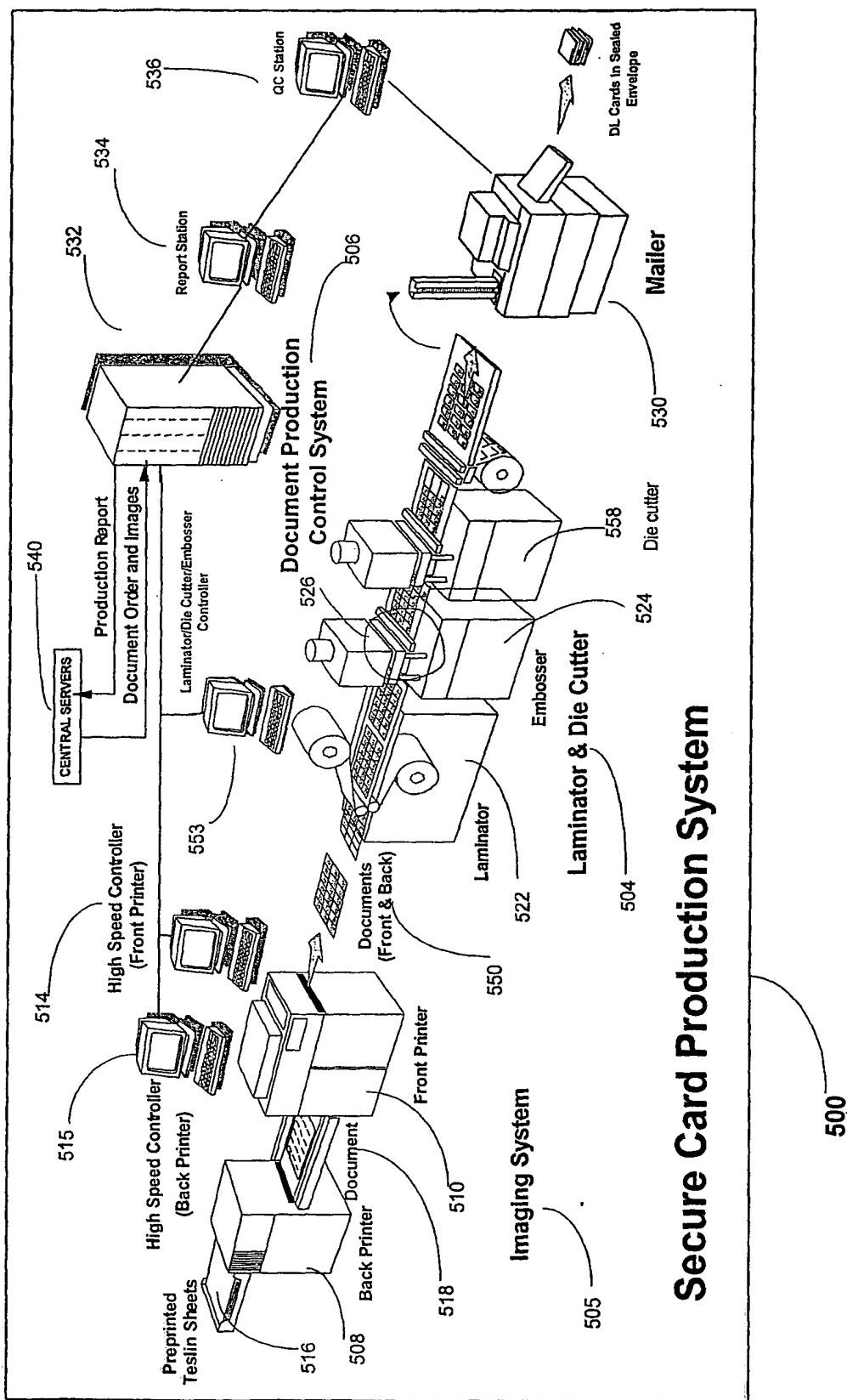


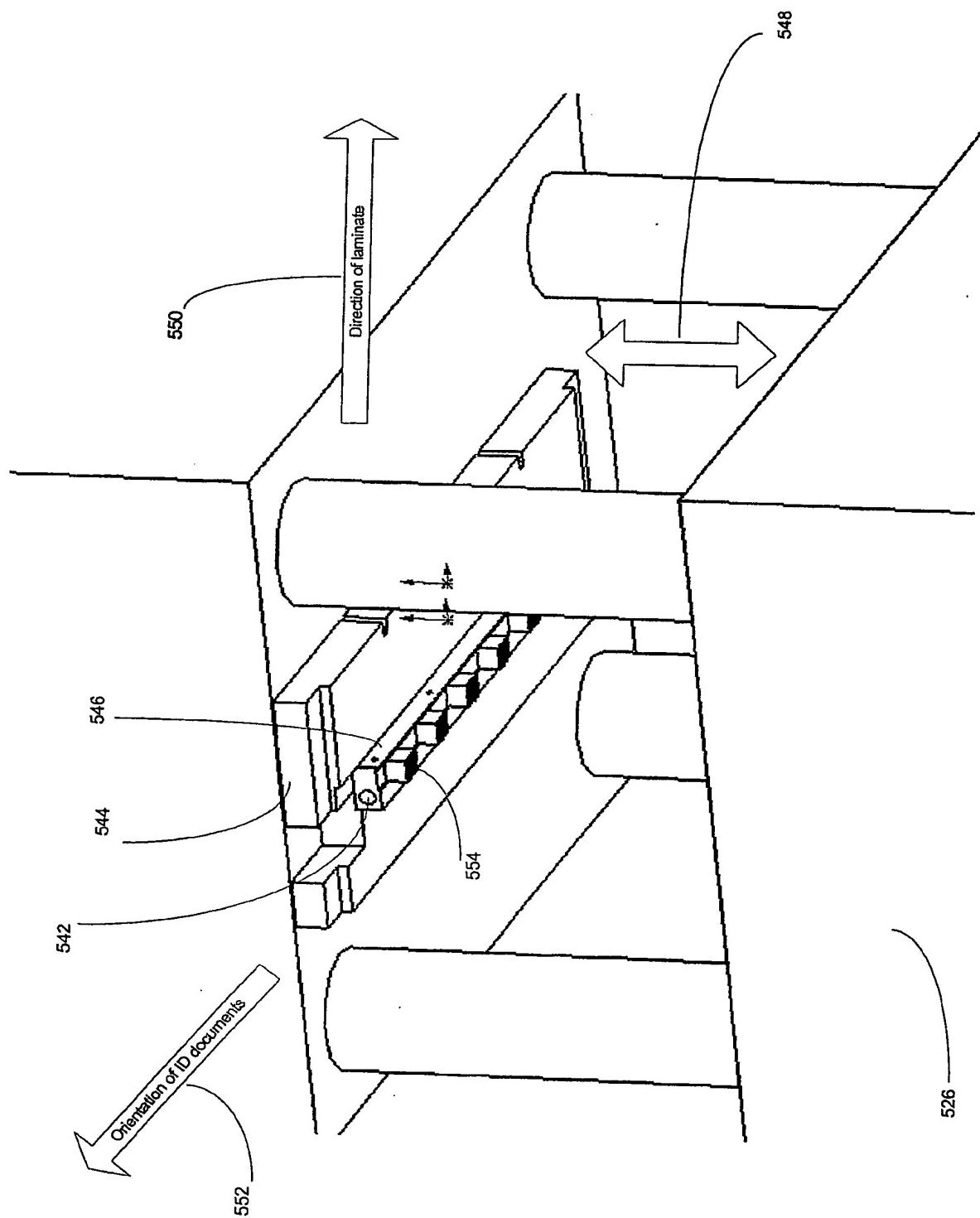
FIG. 11

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**FIG. 12**

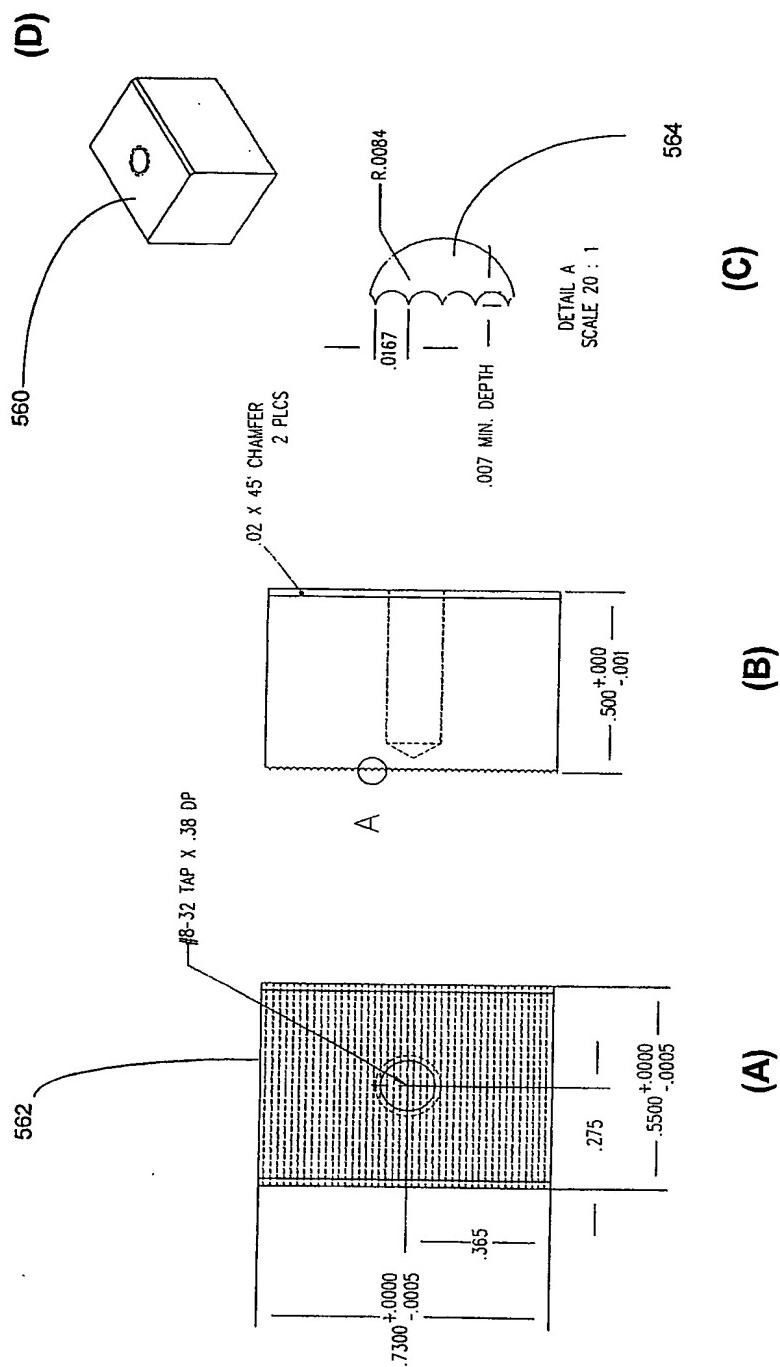


FIG. 13

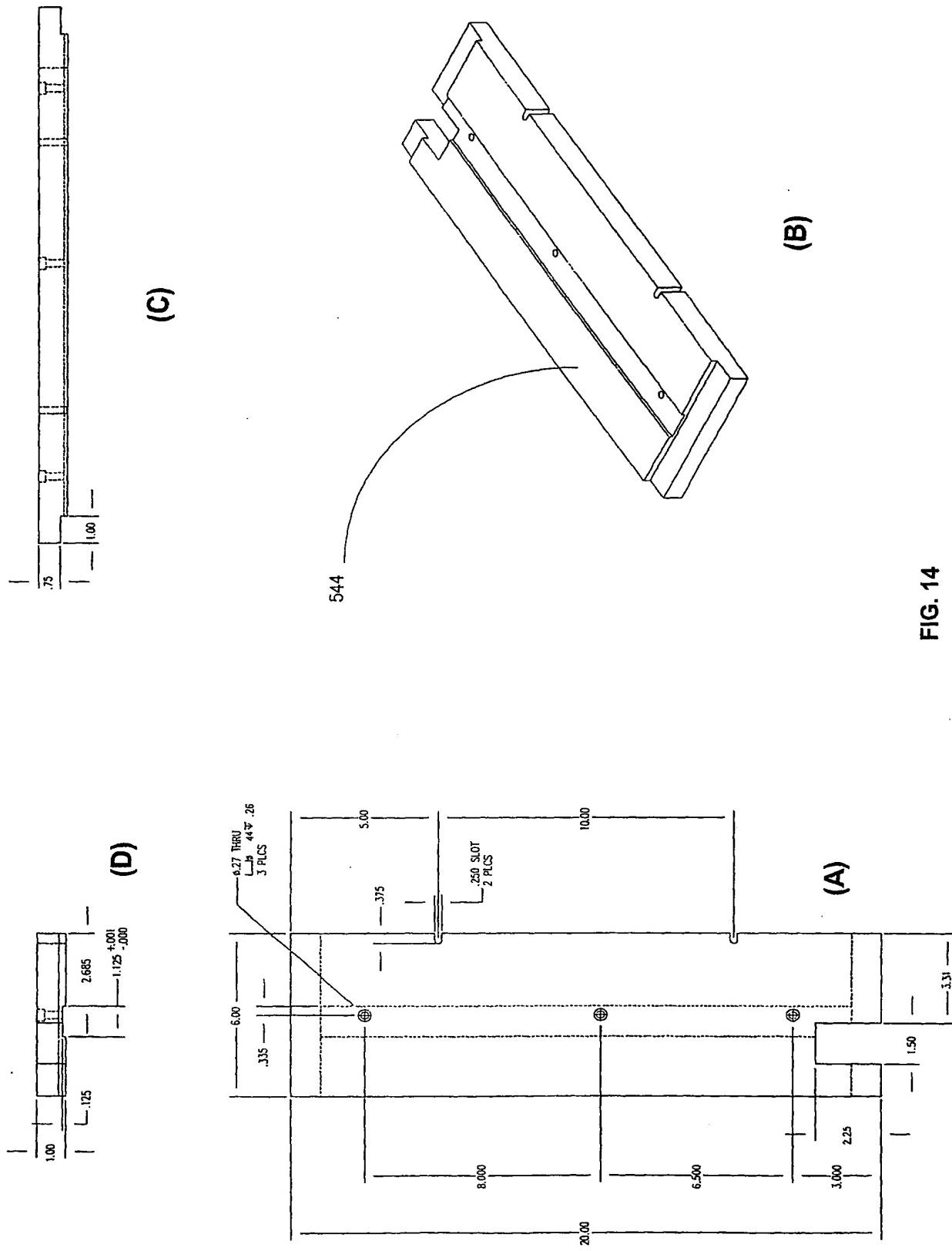


FIG. 14

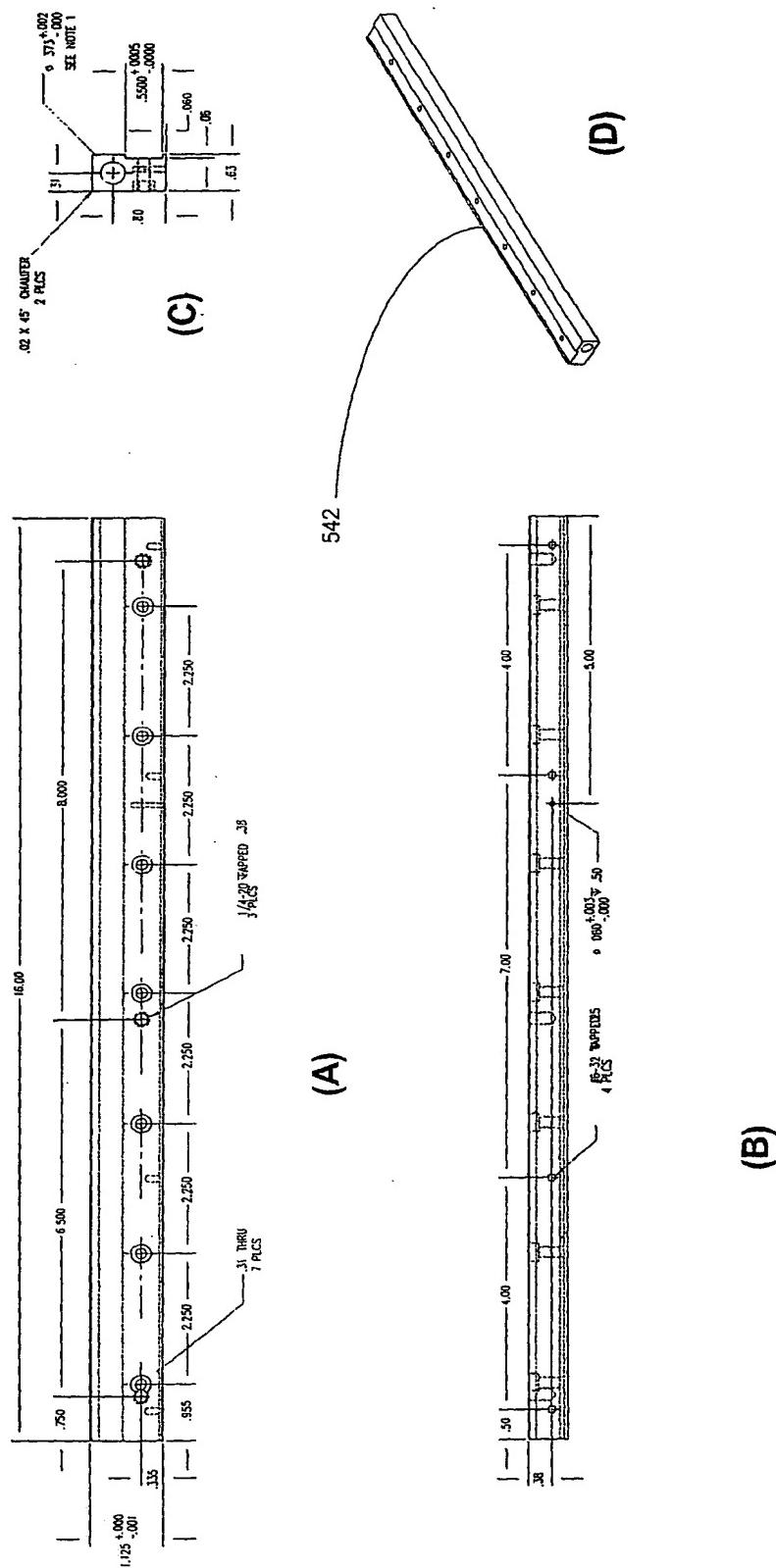


FIG. 15

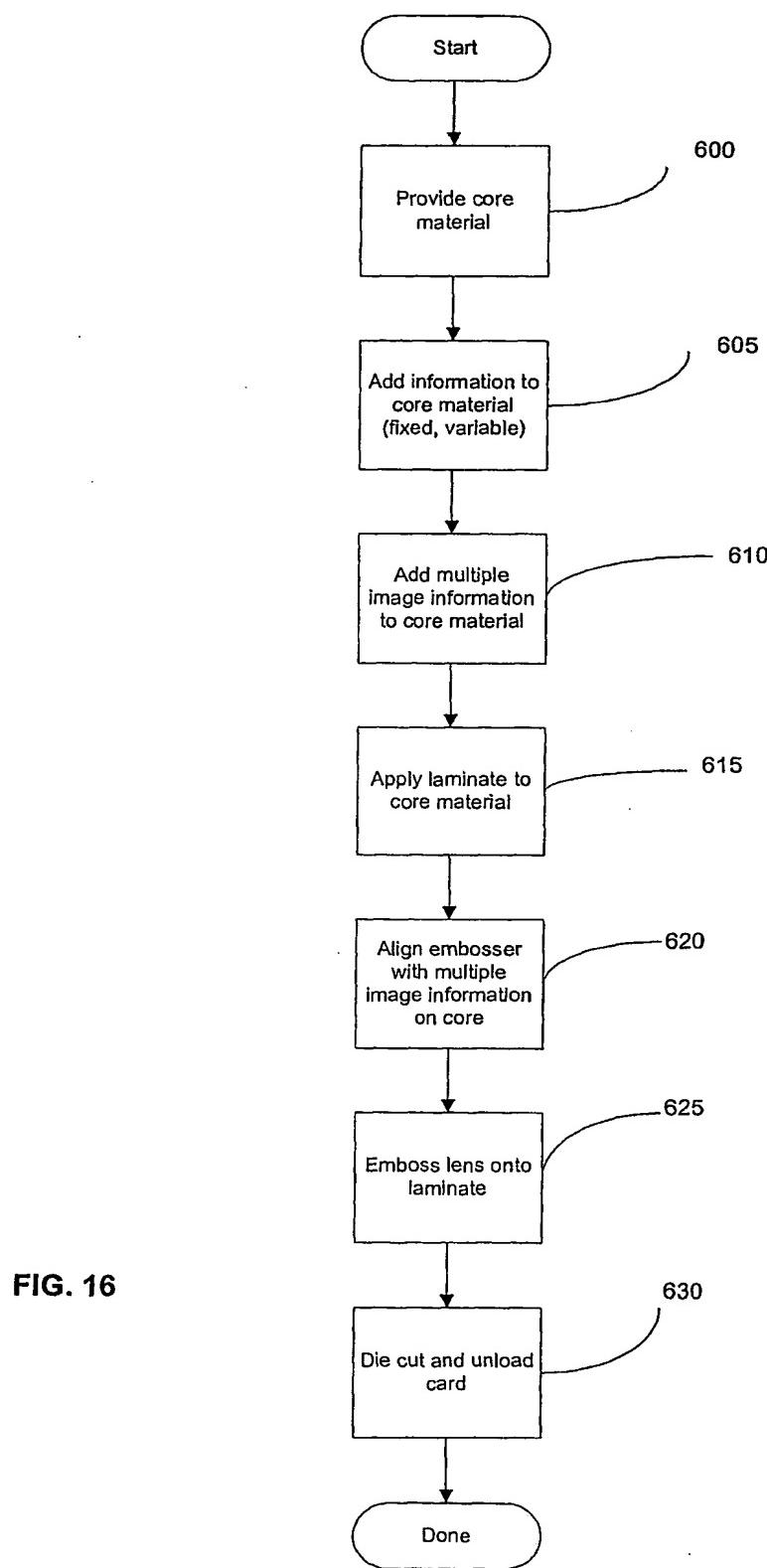


FIG. 16

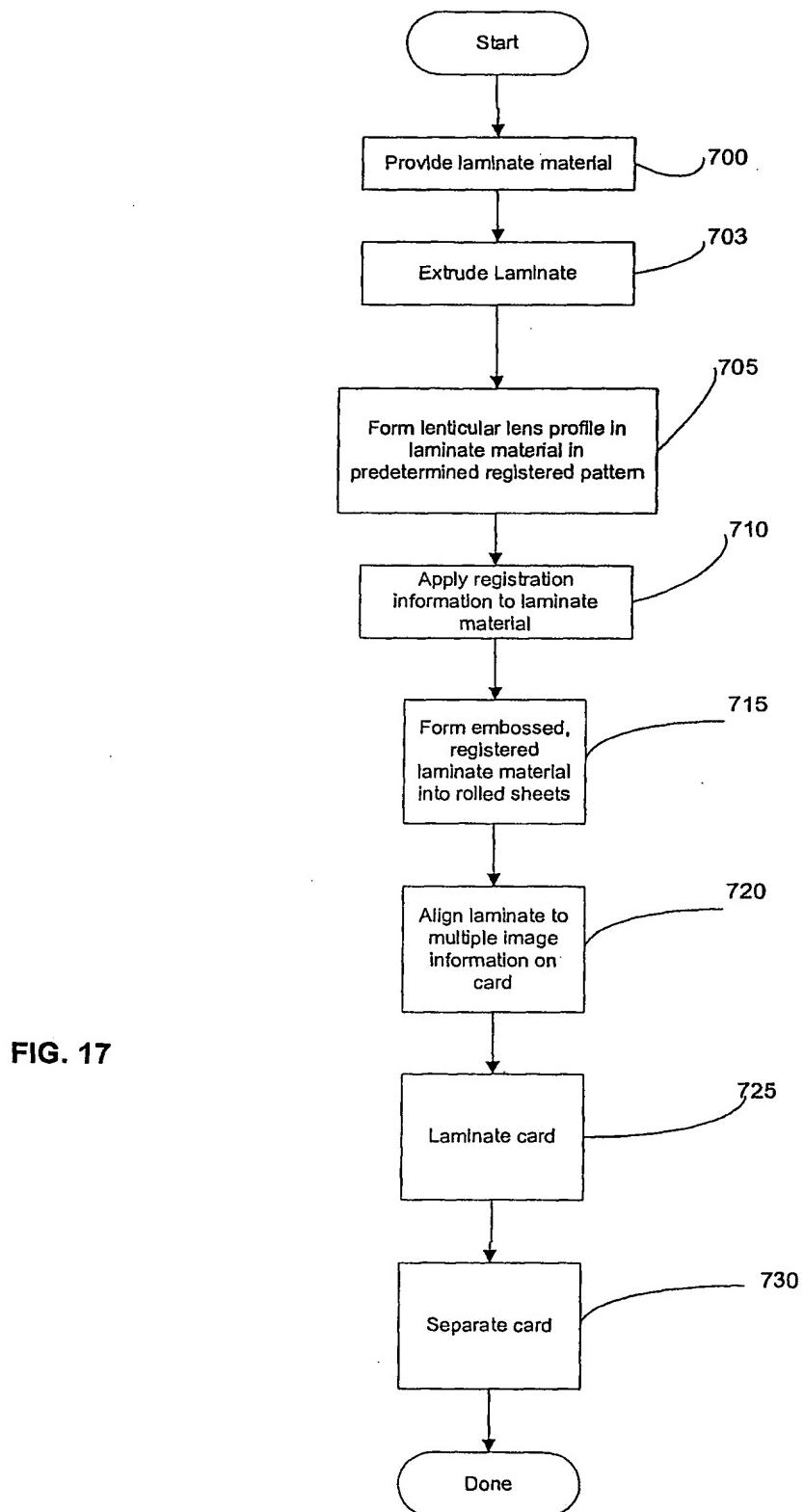


FIG. 17

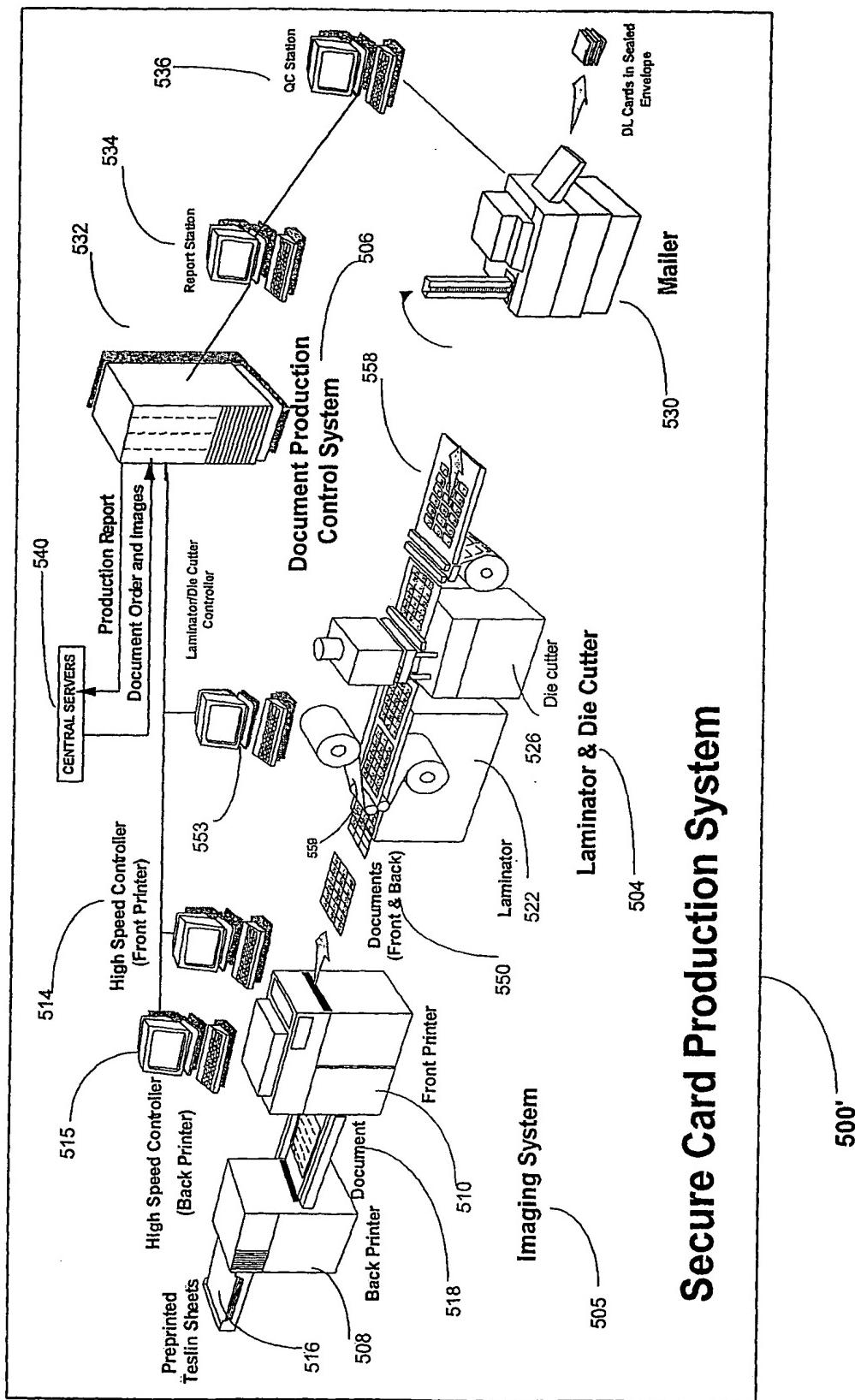


FIG. 18

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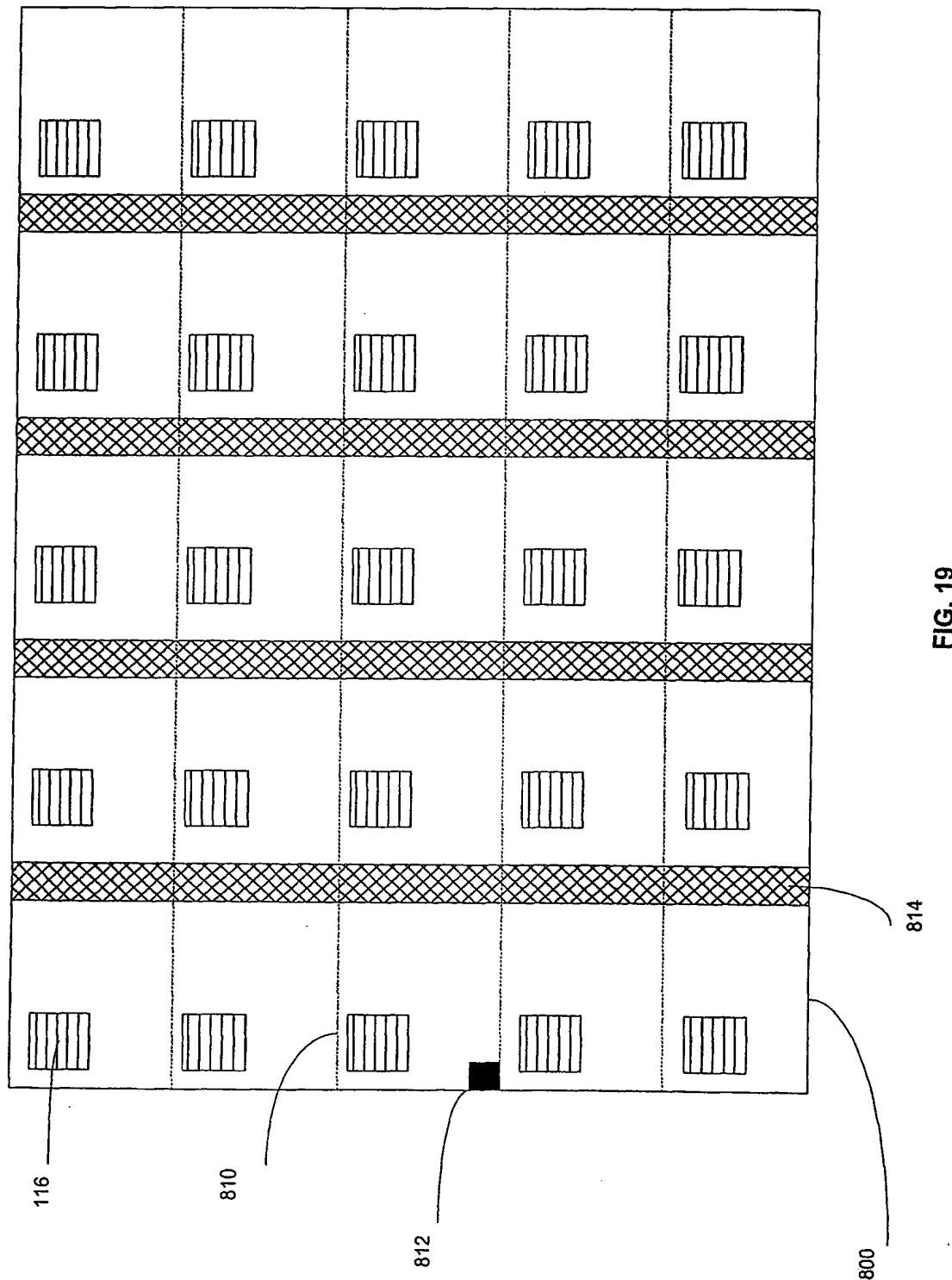


FIG. 19

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/40843

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06K 19/02  
US CL : 235/488

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 235/488, 487; 428/167

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                              | Relevant to claim No. |
|------------|---|-----------------------|
| X          | US 4,869,946 A (CLAY) 26 September 1989 (26.09.1989), column 2 line 55 to column 4 line 55.                     | 1, 4, 6-9, 11-16      |
| Y          |   | 2-3, 5, 10            |
| Y          | US 6,095,566 A (YAMAMOTO et al.) 01 August 2000 (01.08.2000), column 6, lines 15-27 and column 36, lines 21-27. | 2-3, 10               |
| Y          | US 4,765,656 A (BECKER et al.) 23 August 1988 (23.08.1988), column 6 line 25 to column 8 line 60.               | 5                     |
| A          | US 6,234,537 B1 (GUTMANN et al.) 22 May 2001 (22.05.2001), column 4 line 55 to column 5 line 37.                | 1-16                  |

Further documents are listed in the continuation of Box C.

See patent family annex.

|   |     |  |
|---|-----|--|
| * Special categories of cited documents:  | "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  |
| "A" document defining the general state of the art which is not considered to be of particular relevance  | "X" | document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone   |
| "E" earlier application or patent published on or after the international filing date   | "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" | document member of the same patent family  |
| "O" document referring to an oral disclosure, use, exhibition or other means  |     |  |
| "P" document published prior to the international filing date but later than the priority date claimed  |     |  |

Date of the actual completion of the international search

17 March 2003 (17.03.2003)

Date of mailing of the international search report

15 MAY 2003

Name and mailing address of the ISA/US

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